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CONSERVATION ELEMENT FREMONT GENERAL PLAN

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CONSERVATION ELEMENT

TABLE OF CONTENTS

	Page
RESOLUTIONS	ii
PURPOSE, GOALS	vii
OBJECTIVES	viii
PRINCIPLES (IMPLEMENTATION PROGRAM)	x
SUMMARY	1
CONSERVATION ELEMENT	16
GOALS	17
OBJECTIVES	18
DATA BASE	19
LAND RESOURCES	20
WATER RESOURCES	44
MINERAL RESOURCES	65
ECOLOGICAL RESOURCES	74
CLIMATE	87
AIR RESOURCES	91
WASTE DISPOSAL	100
ENVIRONMENTAL CONSTRAINTS	105
APPENDIX	
APPENDIX A -- DESCRIPTION OF GEOLOGIC MAP UNITS	
APPENDIX B -- PLANT & ANIMAL LIFE LISTINGS	
APPENDIX C -- AIR FLOW MAPS	

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RESOLUTION NO. 1915

RESOLUTION OF THE PLANNING COMMISSION OF THE CITY OF FREMONT RECOMMENDING TO THE CITY COUNCIL OF THE CITY OF FREMONT A PROPOSED AMENDMENT TO THE GENERAL PLAN BY THE ADOPTION OF A CONSERVATION ELEMENT, INCLUDING A POLICY TEXT CONSISTING OF GOALS, OBJECTIVES, AND PRINCIPLES, A CONSERVATION DATA BASE,, AND AN ENVIRONMENTAL CONSTRAINTS MAP (GPA-73-6).

WHEREAS, pursuant to Section 65302(d) of the Government Code of the State of California, it is required that the conservation element of the general plan shall be prepared and adopted no later than December 31, 1973; and

WHEREAS, there has been prepared and considered by this Planning Commission a proposal to amend the General Plan of the City of Fremont through adoption of a certain map entitled "Fremont General Plan - Conservation Element - Environmental Constraints" as shown and set forth in Exhibit "A" attached hereto and made a part hereof; and

WHEREAS, this Planning Commission has also reviewed and considered in connection therewith a certain policy text amendment to the General Plan, Policy Text, consisting of Purpose, Goals, Objectives, and Conservation Element (including Goals, Objectives, and Principles), as shown and set forth in Exhibit "B" attached hereto and made a part hereof; and

WHEREAS, this Planning Commission has also reviewed and considered in connection with the foregoing certain background materials not proposed to be included with the Policy Text of the General Plan, but proposed to be included as reference material within the General Plan, consisting of Summary of Findings, Conservation Base, and Appendices A, B, and C, as shown and set forth in Exhibit "C" attached hereto and made a part hereof; and

WHEREAS, this Planning Commission has also reviewed and considered in connection therewith certain additional maps not included within Exhibit "A", such maps constituting reference material proposed to be included in the General Plan, and consisting of the

following: "Fremont General Plan - Conservation Element - Soils" (Map 1), "Fremont General Plan - Conservation Element - Generalized Land Capability" (Map 2), "Fremont General Plan - Conservation Element - Generalized Slope" (Map 3), "Fremont General Plan - Conservation Element - Earthquake Faults" (Map 4), "Fremont General Plan - Conservation Element - Water Resources" (Map 5), "Fremont General Plan - Conservation Element - Mineral Resources" (Map 6), and "Fremont General Plan - Conservation Element - Ecological Resources" (Map 7), as shown and set forth in Exhibits "D-1", "D-2", "D-3", "D-4", "D-5", "D-6", and "D-7", respectively, attached hereto and made a part hereof; and

WHEREAS, this Planning Commission has, after due and proper notice published, held at least one public hearing on said proposed amendment to the General Plan, amendment to the Policy Text of the General Plan, and reference material to be included in the General Plan, as required by law;

NOW THEREFORE, BE IT RESOLVED, that the Planning Commission of the City of Fremont does hereby approve the said proposals as set forth above and in Exhibits "A", "B", "C", "D-1", "D-2", "D-3", "D-4", "D-5", "D-6", and "D-7", as amendments to the General Plan, including reference materials included in the General Plan, and amendments to the Policy Text of the General Plan, and hereby recommends to the City Council of the City of Fremont that the said proposals be adopted.

BE IT FURTHER RESOLVED That the Chairman and the Secretary of this Planning Commission are hereby authorized and directed to endorse said amendments, to show they have been approved by this Planning Commission; the secretary shall thereupon forthwith transmit a copy of this resolution to the City Council of the City of Fremont.

ADOPTED August 23, 1973 by the Planning Commission of the City of Fremont, by the following vote, to wit:

AYES: Commissioners Bertuleit, Helm, Mezzetti, Vollbrecht

NOES: None

ABSENT: Commissioners Avila, Leys, Tissol

ATTEST:

JACOB ROBBINS

Secretary

RICHARD VOLLBRECHT
Acting Chairman

APPROVED AS TO FORM:

Theodore R. Buisler
Assistant City Attorney

RESOLUTION NO. 3329

RESOLUTION OF THE CITY COUNCIL OF THE CITY OF FREMONT AMENDING THE GENERAL PLAN OF THE CITY OF FREMONT BY THE ADOPTION OF A CONSERVATION ELEMENT, INCLUDING A POLICY TEXT CONSISTING OF GOALS, OBJECTIVES, AND PRINCIPLES, A CONSERVATION DATA BASE, AND AN ENVIRONMENTAL CONSTRAINTS MAP (GPA-73-6).

WHEREAS, pursuant to Section 65302(d) of the Government Code of the State of California, it is required that the conservation element of the general plan shall be prepared and adopted no later than December 31, 1973; and

WHEREAS, there has been prepared a proposal (GPA-73-6) to amend the General Plan of the City of Fremont through adoption of a certain map entitled "Fremont General Plan - Conservation Element - Environmental Constraints" as shown and set forth in Exhibit "A" attached hereto and made a part hereof; and

WHEREAS, there has also been proposed, in connection therewith a certain policy text amendment to the General Plan, Policy Text, consisting of Purpose, Goals, Objectives, and Conservation Element (including Goals, Objectives, and Principles), as shown and set forth in Exhibit "B" attached hereto and made a part hereof; and

WHEREAS, there has also been proposed, in connection with the foregoing certain background materials not proposed to be included as reference material within the General Plan, consisting of Summary of Findings, Conservation Base, and Appendices A, B, and C, as shown and set forth in Exhibit "C" attached hereto and made a part hereof; and

WHEREAS, there has also been proposed, in connection therewith certain additional maps not included within Exhibit "A", such maps constituting reference material proposed to be included in the General Plan, and consisting of the following: "Fremont General Plan - Conservation Element - Soils" (Map 1), "Fremont General Plan - Conservation Element - Generalized Land Capability" (Map 2), "Fremont

General Plan - Conservation Element - Generalized Slope" (Map 3), "Fremont General Plan - Conservation Element - Earthquake Faults" (Map 4), "Fremont General Plan - Conservation Element - Water Resources" (Map 5), "Fremont General Plan - Conservation Element - Mineral Resources" (Map 6), and "Fremont General Plan - Conservation Element - Ecological Resources" (Map 7), as shown and set forth in Exhibits "D-1", "D-2", "D-3", "D-4", "D-5", "D-6", and "D-7", respectively, attached hereto and made a part hereof; and

WHEREAS, the Planning Commission, pursuant to law, held a public hearing on said proposed amendment to the General Plan and to the General Plan, Policy Text, and reference material to be included in the General Plan, and did certify its recommendations and findings thereupon to the City Council; and

WHEREAS, the City Council, pursuant to law, has held a public hearing on the proposed amendment to the General Plan and to the General Plan, Policy Text, and reference material to be included in the General Plan, as aforesaid, and did consider said proposed amendments, recommendations, and findings of the Commission;

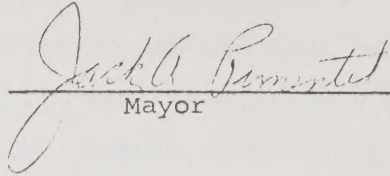
NOW THEREFORE, BE IT RESOLVED, that the City Council of the City of Fremont does hereby adopt the said proposals as set forth above and in Exhibits "A", "B", "C", "D-1", "D-2", "D-3", "D-4", "D-5", "D-6", and "D-7", as amendments to the General Plan, including reference materials included in the General Plan, and amendments to the Policy Text of the General Plan, said maps, policy text, and other materials to be officially designated as the Conservation Element of the General Plan of the City of Fremont, pursuant to the provision of Section 65302(d) of the Government Code of the State of California as amended by Chapter 120 of the statutes adopted by the Legislature of the State of California at the 1973 Regular Session thereof.

ADOPTED September 25, 1973 by the City Council of the City of Fremont, by the following vote, to wit:

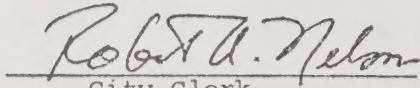
AYES: Councilmen Dillon, Lampert, Rhodes, Steel, Pimentel

NOES: None

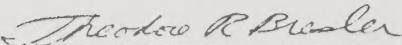
ABSENT: None


Mayor

ATTEST:


City Clerk

APPROVED AS TO FORM:


Assistant City Attorney

PURPOSE

Fremont is a city that presents a variety of environmental conditions — varied topography, baylands, seismic activity, water and mineral resources, plant and animal life. While planning efforts in the past have recognized many of these conditions, the lack of an environmental data base has often hindered an in-depth analysis of prospective development.

The purpose of the Conservation Element is to build into the General Plan those vital considerations of the environment which have not been given due consideration since its inception.

GOALS

1. Modifications of the current state of the environment shall require careful justification.
2. Irrevocable allocation of limited environmental resources shall be carefully regulated in the interest of future generations.
3. The City shall use environmental resources not only in its own interests, but shall also cooperate with and assist in meeting the needs of regional, state and national constituencies in their efforts to achieve certain environmental qualities.

OBJECTIVES

1. The City of Fremont should seek to fully understand the conditions of its environment through research, study and exploration, and should not take major actions affecting the quality of the environment without such understanding.
2. Major physical attributes of the City should be preserved in the interest of providing a varied and stimulating urban environment.
3. Where environmental constraints clearly prohibit development or render it only marginally feasible, alternative uses for lands should be determined.
4. Natural resources of a rare or unique character should be protected from intrusion of incompatible uses in the interests of preserving them for present and future use.
5. Both direct and indirect benefits and costs of natural resource uses should be considered prior to such use; this evaluation should be comprehensive and systematic, should consider alternative uses, and should follow a well-defined format (e.g., benefit-cost study).
6. Justification for natural resources exploitation should not be based solely on the needs of the moment, but should consider resource needs for at least 25 years into the future.
7. If permanent use of natural resource areas for development purposes cannot be clearly justified, these areas should be set aside for disposition in the future, if and when it is justified.
8. Prior to decisions permanently affecting major natural resources, the City should determine the effects of these decisions on the larger regional community which may also have an interest in the use of such resources.
9. The City should continue efforts at educating the public about the character and needs of the environment; these efforts can be both formal ones (e.g., through the public school system) and informal (e.g., through public recreation programs).
10. Specific efforts should be made to protect and preserve the following resources:
 - a. Highly productive agricultural areas;
 - b. Air sheds and watersheds, in their natural functioning states;
 - c. Significant, rare or endangered plant and animal species and habitats;

- d. The intrinsic variety and complexity of local ecological systems;
 - e. Scenic or vista resources, including scenic drives;
 - f. Bayshore lands and wildlife habitat associated with the Bay;
 - g. Woodlands, marshes and streams in their natural state.
11. The City should make every reasonable effort to determine how the people who live within its boundaries feel about their environment and consider these feelings in environmental planning.

CONSERVATION PRINCIPALS

(IMPLEMENTATION PROGRAM)

1. The information contained in this element and related information obtained in the future should be used as a basic data source in evaluating future City plans and development proposals, particularly through the Environmental Impact Review process.
2. The Open Space Element should use open space as a means of dealing with environmental constraints. The City should investigate and develop programs for open space implementation such as acquisition, land-banking, zoning, easements and specific area planning that are based on, among other things, the Conservation Element's environmental constraints.
3. The City should participate in the programs and efforts of area-wide agencies, including ABAG, BCDC, East Bay Regional Park District and Alameda County, to protect and foster wise use of natural resources in the area; such participation should also be extended to State and Federal agencies seeking similar ends.
4. Filling of Bay waters, marshes and mudflats (or any other activities which tend to reduce tidal flushing and circulation) shall be expressly prohibited, except for minimal filling for open space and recreational uses; the policies of BCDC shall be strictly followed by the City.

GEOLOGIC PRINCIPLES

1. The City should, at the first opportunity, sponsor a complete, detailed geologic study of its territory.
2. Land use activity involving modification of the land surface should be strictly regulated and in questionable cases prohibited until a geologic study provides guidelines for land use.
3. Any changes in the existing natural system of balances in the hills should be allowed, only within the framework of environmental constraints. These "changes" could include grading, removal of plant cover, introduction of large amounts of water, overgrazing and exposure of open soil or rock.
4. Any development proposals for the hills should be required to submit a comprehensive on-site geologic study evaluating the short and long-term effects of the proposal upon the geologic structure and stability of the hills.

SOIL AND LAND CAPABILITY PRINCIPLES

1. Soils information should be used in evaluating future City plans and development proposals.
2. Land Conservation contracts pursuant to the California Land Conservation Act of 1965 (Williamson Act), although short range, shall be encouraged as a means of preserving the City's prime agricultural areas as open space for food and fiber production.
3. Where practical, Class I and Class II soils should be set aside, either through agricultural preserve, open space designation, or as a City-managed land bank, for the production of agricultural crops.
4. Most Class VII and VIII lands should be restricted from intensive urban-type development, due to the large array of problems and constraints inherent in them. They should be placed in an open space classification or used as pastureland or recreational land.
5. Other lands, including Class III, IV, and VI (no Class V lands have been designated in the City) soils, can generally be used for normal urban development, provided that suitable precautions are taken against the hazards (slope, erosion, soil creep, structural damage from shrink-swell) presented by specific soil types within the categories. Development proposals must be accompanied by specific solutions to any hazards involved.
6. Septic tanks will be permitted where public sewers are not available and the extension of public sewers is economically infeasible and septic tanks are in the opinion of the Alameda County Health Department permissible.
7. The City should require a geologic/soils investigation for each major development proposal, to be carried out by a qualified consultant. Minor development proposals may be required to provide a geologic/soils investigation. The depth of such investigation shall be as determined by the seismic element.

SLOPE

1. Areas with slopes of 15% or less may be developed in accordance with the existing regulations and procedures of the City.
2. Low-density development and small clusters of development on large sites can be permitted in areas with slopes of 15% to 29%, where such development will not create a public hazard

or destroy the natural environment. Special design and development review standards and procedures should be developed and applied to proposals for such hillside areas.

3. As a general rule, urban development should be prohibited on slopes of 30% or greater.
4. Special planning procedures, such as target planning, and performance standards involving the siting and appearance of development on slopes in excess of 15% should be developed and used prior to actual building on hill areas.

SEISMIC HAZARD PRINCIPLES

1. The City should, in the very near future, prepare a Seismic/Safety Element with the help of qualified consultants.
2. Where generalized soils or geologic surveys indicate evidence of geological hazards on a given parcel, development should not occur there unless it is clearly demonstrated that seismic activity will not cause adverse affects.
3. Until faults and traces within the City are thoroughly documented, buildings for human habitation or use should not be permitted in a corridor 50 feet on either side of a documented fault or trace, or 75 feet on either side of an inferred or suspected fault or trace without the benefit of a soil and geologic survey.
4. Where there is reasonable evidence of other seismic hazards, such as landslides, development should not be permitted until the area is thoroughly studied and it is concluded that no seismic hazard to human life will exist.

GROUNDWATER PRINCIPLES

1. The City of Fremont and the Alameda County Water District should establish a joint, permanent Planning Coordinating Committee to consider issues of long-range significance in the conservation of, demand for, and supply of water as it relates to the planning program of the City.
2. The City should support the efforts of the District to reclaim the Niles Cone groundwater basin.
3. The impact of maintaining a Bayward gradient in the Niles Cone upon the groundwater levels in low elevation portions of the City should be determined at the earliest opportunity.

If these areas will be rendered undevelopable by rising water levels, they should be redesignated on the General Plan from an urban to a non-urban land use.

SURFACE WATER

1. The City of Fremont and the Alameda County Flood Control and Water Conservation District should establish a joint, permanent Planning Coordinating Committee to serve as the principal vehicle for discussion and resolution of long-range matters of common interest and to gain a better understanding of the relationships between urban development and surface water conditions.
2. The effects of hill area development on system overloading and water erosion must be completely studied prior to any development in the hills. The utility of natural watercourses as unimproved drainage facilities must be considered and efforts made to preserve streams in their present state for drainage, recreational and aesthetic purposes.
3. Natural Science Centers and "Land for Learning" programs should be staffed by personnel qualified in the natural science field.

ECOLOGICAL RESOURCE PRINCIPLES

1. An Environmental Data Bank must be established that can be kept up to date concerning information on plant and animal life, as well as other environmental concerns. The information can then be used in the Environmental Impact Review process.
2. The City should promote a "land for learning" program in cooperation with local educational agencies.
3. The City should hire a Park-Ranger Naturalist to aid in interpreting environmental data and to insure that a well-rounded natural science program is maintained.
4. Additional sites for Natural Science Centers should be investigated to ensure that natural science training can be conducted about as many different habitats as possible.
5. The City should support and assist Federal efforts to improve the South San Francisco Bay Wildlife Refuge.

MINERAL RESOURCE PRINCIPLES

1. The City should continue to gather information about the extent and value of its mineral resources, especially in reference to those for which regional or local demand may increase markedly in the next few years.
2. Local salt production should be encouraged, in view of the importance of that industry in the City, region and State. However, when salt production ceases in an area, salt marsh, rather than urban areas, should take its place.
3. The City should explore the alternatives of reserving potential mineral extraction sites or permitting their development into other types of urban uses.

CLIMATE AND WEATHER PRINCIPLES

1. Homes should be insulated to conserve energy used in heating and air conditioning.
2. Development patterns, site plans and building designs should take account of wind direction and speed, especially where ridgetop development will be exposed to the most severe winds.
3. Because foliage has a marked effect on reducing wind, lessening temperature extremes and reducing solar evaporation, stands of trees should be planted to serve as windbreaks and shelters.

AIR QUALITY PRINCIPLES

1. The City, should continue to support the effort of local, regional, State and Federal agencies to combat air pollution problems and should work actively with the Bay Area Air Pollution Control District in evaluating the effect of land use decisions on air quality.
2. Because of the direct correlation of the numbers of motor vehicles and air pollution (oxidant, carbon monoxide and nitrogen dioxide in particular), the City should begin considering ways

of reducing dependence on private motor vehicles for transportation by its inhabitants, including:

- a. Development of alternative local transportation systems, such as bicycle and bus facilities;
 - b. Reduction in the emphasis on broad, multi-laned thoroughfares and streets and drive-in enterprises which encourage private auto and truck travel and present hostile environments for bicycle or pedestrian travel;
 - c. Development of the City on a more vertical, rather than a totally horizontal scale, to lessen the distances between activities and reduce the need for private transportation.
3. Reservation of large open space lands within the local air basin to reduce the generation of pollutants and contribute to the cleansing of the air through normal photosynthesis.
 4. The City should continue to support attempts to establish sound regional transit facilities, such as BART, which will provide alternatives to intercity auto transportation.

WASTE DISPOSAL PRINCIPLES

1. **Sewage.** The City should carefully coordinate development approvals with the capacity of sewage treatment facilities and should continue to support the development of a regional advanced waste treatment system.
2. **Solid waste.** The City should determine the availability of suitable land fill sites well in advance of the completion of the Durham Road fill, and should participate in and implement the County solid waste disposal plan.



SUMMARY OF FINDINGS

LAND RESOURCES

Geology: Fremont is located on a broad alluvial plain, formed by sediments deposited by the long term erosive action of water flowing from the hills over the underlying bedrock. The bedrock surface rises sharply beneath the City's hill areas, which make up the westernmost portion of the Diablo Range. The hills are made up of a complex of rocks and limestone known as the Franciscan Assemblage, from periods some 70-180 million years past. More recent materials (3-40 million years old), also found in the hills, are moderately to well consolidated rocks which have a poor bearing capacity and tend to slump badly on slopes steeper than 2 to 1 (50%). The hill surface is only a thin coating of relatively poor quality soil covering the rocks, as much of the soil produced has been, and is continuing to be, eroded away by wind and water action.

Geologic Forces: The hill areas are subject to such forces as soil creep and land slides which present several problems to intensive land use. Wind and water also produce erosion, and water can accelerate soil creep. These factors become more critical as slope increases. In addition, the greater the slope the more grading excavation and terracing that is necessary for urban dwellings and streets. Map 3 illustrates slopes.

Soils: There are many different types of soils and each has natural attributes which gives it a certain character and capability in terms of agricultural use or urban development. By combining the soil type with such things as slope and effective depth, a land capability can be obtained for a given area. Land capabilities go from Class I for soils that have few limitations affecting use to Class VIII, where soils and land forms have limitations that preclude their use for purposes of urban development or commercial plant production, and restrict their use to recreation, for wildlife, water supply, or aesthetic purposes. While some areas of Fremont are Class I prime agricultural land, others are Class VIII with severe limitations for almost every use. (Map 1 shows soil types) and (Map 2 shows land capability)

Seismic Hazards: Map 4 shows the general location of earthquake faults in Fremont. Earthquake faults affect an area in several ways.

1. **Creep** is the slow movement of land surface along a fault or fault trace, and is presently occurring along the Hayward fault. Creep can cause offset in roads, fences, railroad tracks and can cause damage to structures located over a fault. Another form of creep was discussed under geology and soils. Seismic shaking can vastly increase the rate of creep and can accelerate it into landsliding especially if the soil is moist.
2. **Landslides** can occur in connection with earthquake activity as was noted above. Such

earth movement has severe implications for structures on the surface of a slide as well as in its path.

3. **Seismic motion** is a form of low-frequency wave motion which can create severe **ground shaking** large distances from the epicenter of the earthquake. The intensity is dependent on the geologic structure of the area in question.
4. **Liquefaction** is a phenomena of earthquakes where certain types of soil will take on a near liquid composition from subsurface water being forced upward toward the surface, acting much like quicksand. Where liquefaction has occurred, structures and other relatively heavy objects have been known to sink into the earth.
5. **Surface rupture** is the splitting or cracking open of the earth's surface along a fault or trace. There is evidence to conclude that surface rupture is not always confined to a past fault or trace.

WATER RESOURCES

General Hydrology: Fremont is located at the westernmost extremity of the Alameda Creek Basin, which is a large watershed encompassing not only the Tri-Cities area, but the Livermore Valley, the cities of Livermore and Pleasanton, Del Valle Reservoir, etc. The basin has a land area of about 695 square miles. The larger interior portion is connected to the western portion by Alameda Creek, which flows through Niles Canyon and ultimately drains into San Francisco Bay. (Figure 2)

All streams of the basin are intermittent, with flows depending on seasonal precipitation. In many cases, however, there is a continuous flow of water in the streambeds even though there may be none on the surface. Alameda Creek itself flows continuously, in part because of the introduction of stored and imported water supplies to it as it passes through the basin. The City's setting in this large basin is important, because activities or events affecting the nature of the water supply, drainage, quality of water and so on in the upper, or eastern, portion of the basin will have an impact on the nature of the water which reaches Fremont. For example, pollution of surface water in the Livermore Valley will result in polluted water passing through Fremont. Greater demand for water from that area will reduce Fremont's supply.

Groundwater: Fremont overlies a large subsurface basin, the Niles Cone, formed from bedrock and extending downward more than 800 feet. This basin is filled with layers of silt and clay, which tend to be impermeable to water, and alternate layers of sand and gravel, which store water. These water-bearing layers are identified as aquifers. These aquifers are separated by layers of impermeable material (aquicludes) throughout most of the Niles Cone, although immediately west of the Hayward Fault there is some movement of water between aquifers. The fault impedes the underground flow of water in the Niles Cone in an east-west direction across the fault line. (Figure 3)

Under normal conditions, groundwater would be pumped. The basin is recharged by water percolating downward.

The importance of maintaining an even balance between water usage and water supply to the basin is not only emphasized by the need to retain a reserve of potable groundwater, but is critical due to proximity of the Bay. The level of the groundwater must remain higher than the Bay (sea level) in order to create a bayward "gradient" which will hold back bay salt water from entering the system.

The water levels of the aquifers in the Niles Cone were gradually drawn down to a point far below natural levels: in 1961, the groundwater level was 67 feet below sea level. As a result of this, saline water from the Bay entered the Newark Aquifer, traveled along

the aquifer to a point near the Hayward Fault, and then traveled downward into the Centerville and Fremont Aquifers (see Figure Three). At the present time, the Newark Aquifer is largely degraded by brackish water, and the two lower aquifers have suffered serious damage. According to the Alameda County Water District, about 1,000 acre feet of salt water entered the groundwater basin between the Fall of 1971 and the Fall of 1972, indicating that the natural balance described above had not yet been restored, although it has been brought up to within two feet of sea level. The District is proposing a program of pumping saline groundwater that is trapped in aquifers beneath the Centerville District and Newark and discharging it into the Bay, while at the same time increasing the amount of imported water to be added to the recharging pits.

The Alameda County Water District uses water from four sources: groundwater, pumping, San Francisco Water Department pipeline (Hetch-Hetchy), the South Bay Aqueduct and Del Valle Reservoir. Projections meeting water demand to 1995 assume reclamation of the groundwater basin and renewal of the SFWD contract (which expires in 1984). Beyond 1995, new sources of water will be needed.

Surface Water: Surface water includes oceans, lakes, ponds, rivers, and streams. Though generally not used directly for human consumption it has aesthetic and recreational purposes and provides habitat for many plants and animals.

When rainfall reaches land, it can be absorbed into the soil depending on the particular type of soil or it can run across the land, sometimes carrying some soil, to the lowest accessible point — in Fremont, the Bay. Pockets of land lower than sea level become ponds. If rain falls on land that has been surfaced or built upon, it runs off at a higher rate. Fremont is divided into watershed areas; a watershed being an area where all rain falling can potentially end up at a given point, or that all water in a given stream comes from a given area. While Fremont has many small intermittent streams, Alameda Creek is the largest body of flowing fresh water in the City. Although the streams become dry on the surface in the summer, water remains below the surface of the stream bed.

Because of the flood hazard in the City and surrounding areas, the Flood Control District has developed a complex series of flood control channels, conduits and ponding areas designed handle a "15 year storm" (Map 5) According to the District, the system is designed to handle increased runoff from urbanization on the flatlands, but development in the hill areas may well overload lower (downstream) segments of various lines. The District has proposed a number of additional improvements throughout the City, including some work in the hill areas which would involve maintaining the integrity of the natural watercourses though removing debris from the channels. This is important because artificial channelization of the hill area streams would simply increase the velocity of water and would further overload

downstream facilities.

Water Quality: In a 1972 U.S.G.S. study of wells using the Niles Cone groundwater basin, high levels of salt, nitrate and boron were noted. Salt water intrusion has been discussed. The other two chemicals can occur naturally in rocks, water and soil. Additional sources of nitrate include decomposing wastes from canneries, septic tanks, etc. While the quality of surface water is generally good, there are some pollution problems in Alameda Creek and other streams which stem from municipal and industrial waste disposal systems in the upstream areas such as the Livermore Valley. U.S.G.S. is proposing a basin-wide monitoring system. (See figure 4)

ECOLOGICAL RESOURCES

Three distinct ecological zones exist within the City of Fremont: the Baylands, the flatlands and the hill areas. Within these broad zones are numerous smaller zones, each with its own set of natural conditions that support certain forms of life. (Figure 5 illustrates plant and animal life relationships.)

Baylands: The Baylands includes salt ponds, salt marshes, tidal flats, upland and open water each having its own distinct environment. The endangered California clapperail, two depleted song sparrow subspecies and the endangered salt marsh harvest mouse depend on the marshes for survival. Nearly 70% of the Pacific Flyway birds, at some time of the year, depend on the South Bay tidal flats for life requirements. The endangered California least tern nests in the uplands, while harbor seals, once nearly extinct in the South Bay, number nearly 200 in Mowry Slough. Fortunately, most of the Baylands are now included in the San Francisco Bay National Wildlife Refuge; about 12,500 acres are planned to be acquired in Fremont. While the refuge covers a vast area, there may be sensitive areas immediately adjacent to the wildlife refuge. Development in these periphery areas should be carefully considered and subject to full environmental impact review.

Flatlands: While most of the flatlands are urbanized, two important ecological areas exist. While the overriding importance of the Northern Plain rests in its prime agricultural land, Coyote Hills and the Patterson Eucalyptus Grove represent significant ecological units. Central Park and the Natural Science Center is a second significant area.

Hills: The hill areas are made up of grassland, brushland and woodlands. While much still needs to be learned about the ecology of Fremont's hills, significant canyon environments have been identified: Niles Canyon, Morrison Canyon, Mill Creek Road and the canyons of the West Mission Hills area. The canyons contain a variety of plant and animal life consisting mostly of oak woodland, riparian woodland, and broadleaf evergreen forest, along with brushland in the upper reaches of the canyons.

MINERAL RESOURCES

All identified mineral resources are of the common type, but are still valuable to the City, especially since many of these resources are vital to the construction activity of the Bay Area, and most of them have a high weight-to-value ratio which requires that they be located near their markets.

Sand and Gravel: The tonnages used are obtained primarily from shallow alluvial cone deposits of the Alameda Creek basin in the Niles-Centerville area of Fremont, and from valley fill alluvium along Arroyo del Valley and Arroyo Mocho in the Livermore-Pleasanton area. Both sand and gravel are relatively expensive per unit of value to transport (the present economic limit is about 40 miles). As a result, demand tends to concentrate near the areas of greatest population growth, which includes the East and South Bay areas.

Current extraction activities in Fremont take place at five major quarries (Map 6). In addition, the U.S.G.S. has tentatively identified a vast sand and gravel deposit in the Fremont area which dwarfs those presently covered by City use permits (Map 6). It appears in two different parts of the City. The first occupies about 3500 acres west of Niles Canyon, and the second covers about 1000 acres southwest of Mission San Jose. The fact that the areas are located in the path of urban growth (parts of them are already covered by the City) lessens the chances of the deposits being used in the near future, if at all, unless demand becomes great enough to price sand and gravel-bearing lands above lands for urban development. The U.S.G.S. has predicted that by the year 2000, readily available sand and gravel resources in the region may be exhausted (given anticipated construction trends), and material will have to be imported, which will drive the price up. Whether or not this will lead to strong pressures to use Fremont's resource remains to be seen, but the City should look into the matter in more detail and begin to formulate a means to cope with the question when it arises.

Crushed and Broken Stone: The majority of this material is used as aggregate in asphalt paving, subgrade roadbed material and foundation material. In Fremont, the hill areas, which are composed primarily of the Franciscan Assemblage (see Geology chapter), are rich in conglomerate, which consists of folded or broken sedimentary rock with abundant fragments of pebble or large size in a matrix of sand and finer grained materials. This conglomerate is a basic source of material for the stone industry.

There are presently two stone quarries in Fremont (Map 6): Bellini and Leslie. The limit of production is stipulated by the City in the rehabilitation plans for the operations, which indicate the condition the site must be in when the quarries close. The stone resource base in the City is more than adequate to meet anticipated needs, although the impacts of

additional quarrying may be serious enough to result in limitations of the place and extent of the activity.

Salt: In the Bay Area, solar evaporation has been modernized and perfected, due to the influence of three major factors: climate (dry, warm, windy summers which speed evaporation), land (thousands of acres of low-lying salt marsh create ideal evaporation pond sites), and market (domestic and industrial consumption — in California, industry uses 65% of all salt produced in the Bay Area). As a result, salt production is a major industry in Fremont, and serves a large and ready market in the Bay Area. Map 6 shows salt pond location.

Fremont plays a major role in salt production for both the region and state. Salt ponds also constitute an important wildlife habitat. The newly established wildlife refuge allows continued production of salt through solar evaporation. The relative benefits of salt marsh vs. salt ponds is a subject of some debate; it has been suggested that the latter are more conducive to a "natural" ecological cycle of the type historic to the Bay. For this reason, it can be recommended that the salt industry be encouraged to continue because of its importance to the City and region, but that lands not functioning well as salt ponds be allowed to revert to salt marsh or tidal flat.

Other Mineral Resources: While there are known clay deposits (Map 6) and industry related to them in Fremont, no detailed state-wide information on clay deposits and potential resources is available. A soils map of the state will show that large reserves of miscellaneous clay appear to be present. As with other mineral resources found in Fremont, proximity to a ready market — the Bay Area — is of prime importance.

Fremont has two hot mineral springs which have been identified by the U.S.G.S. as having regional significance. One is in a canyon north of the Niles area near an operating rock quarry, and the other is at the historic Warm Springs hotel-Stanford Winery complex in the Warm Springs area (see Map 6).

In its yet-to-be-published study of Bay region resources, the U.S.G.S. has indicated that large quantities of limestone may be located in the City, beneath the Bay itself. According to the agency, the entire Bay floor within the City limits may be underlain by quaternary seashell deposits (see Map 6) to a magnitude of possible importance to the entire region. These deposits have been exploited in other portions of the Bay Area, but those in Fremont are as yet untouched.

California's limestone reserves are very large and are more than adequate for the foreseeable future. But, as with sand and gravel, transportation costs are a major portion of product

costs. Since limestone is central to the production of cement, sources of the material must, for economic necessity, be close to markets; a local supply is therefore important to the Bay Area. It is estimated by U.S.G.S. that present local sources of limestone may be exhausted within the next decade or two, and new sources may have to be found if present demand trends persist. At that time, demand may grow for exploitation of Fremont's resource.

CLIMATE

Fremont is fortunate to have what has been termed a Mediterranean climate, which is characterized by warm, dry summers and cool, moist winters. This condition is due to the proximity of the Bay, which acts as a massive moderator of temperature extremes. Most of the rain occurs between the months of November through March, and the rest of the year is relatively arid. Annual rainfall is variable, amounting to as little as 8-9 inches per year, to as much as 30 inches per year. The annual average is around 15 inches per year. Temperatures are variable within a relatively small range, averaging from about 45° during the cool season to around 90° during the summer (they rarely go above 90° during a normal season). Relative humidity ranges from 80-85% at night to around 65% during daylight winter days and around 65% during daylight winter days and around 55% during daylight summer days. Summer days are normally clear or slightly hazy and winter days are often overcast with low clouds or fog.

The most prominent characteristic of Fremont is the constant wind which occurs each afternoon from the temperature differentials between the land mass and the Bay. This wind blows from a northwesterly direction, off the Bay, at an average speed of nine miles per hour, and provides a strong cooling influence to the Bay Plain. Strong winds (35 mph to 85 mph) can be expected once every two years. In certain parts of the City, depending on topographic conditions location of structures, foliage, etc., winds can reach higher speeds than the average. As the moving air masses strike the hills and are deflected upward, speeds can increase as friction induced by the valley floor lessens. Winds are especially strong across the ridgetops of the hills and give the more exposed portions a "scoured" appearance; wind action is partially responsible for the rolling, rounded shape of the hills. Wind action also creates a wind chill factor which, when temperatures are low and humidity is high, can create a feeling of much cooler temperatures than the thermometer might indicate; this is especially true to exposed areas.

The cooling effect of the wind also creates temperature inversions, which are layers of cool air next to the ground overlain by layers of warmer air. This phenomenon has the effect of trapping the cooler air and whatever it contains in a low-lying layer; at times of high pollution levels, the layer can become quite visible as the pollutants are trapped below the inversion. The height of the inversion layer is often less than 1,400 feet MSL in summer, which allows the hills to trap the inversion on the plain.

AIR RESOURCES

Because of the inversion factor and wind, Fremont receives more than its share of pollutants; the prevailing westerly and northwesterly winds tend to blow much of the polluted air of the Bay Area toward the east and southeast Bay cities, of which Fremont is one. Inversions (see Climate chapter) tend to form on the Bay plain and trap this air. While Fremont can and should take its own actions to improve air quality, pollution abatement procedures must be area-wide.

The Bay Area Air Pollution Control District is a regional agency, established in 1955, which is charged with the monitoring and control of air pollution sources within the Bay Area. It does not, however, have jurisdiction over motor vehicles, which are regulated by the State and Federal Governments, although statistics and information on vehicular air pollution are generated by the agency. The generation of air pollution is partially local in nature, and can be materially affected by local land use and transportation system decisions.

Air pollution includes:

1. **Particulate Matter:** This includes smoke, pollens, dusts, chemical by products, lead particles from auto exhausts, etc., some of which are highly toxic and contribute to the darkening of the atmosphere.
2. **Gases** react with one another to produce haze, cause damage to living plants and animals, and create unpleasant odors. They are emitted from both stationary sources and from automotive exhausts.
3. **Photochemical Smog:** This is a term given to the product of reactions between nitrogen dioxide and organic compounds (gases) in the atmosphere, which occur most often on warm, windless, sunny days — the sun causes the reaction between the organic compounds (hydrocarbons) and the NO_2 and forms smog, which includes the chemical Ozone. Other oxides of nitrogen can react with other compounds to form photochemical smog; these reactions depend on clear, sunny and warm conditions, which are common in the Bay Area during the summer. Sources for the reactive chemicals are auto exhausts and the burning of organic materials.

Recent trends indicate that air pollution is slowly being abated, but this trend may be in jeopardy with more growth and more automobiles. Fremont, along with Livermore and San Jose still alternately lead the Bay Area with different types of high air pollution levels.

WASTE DISPOSAL

Solid Wastes: Disposal activities take place on a 260-acre site located at the eastern extremity of Durham Road. The site operates under a City use permit which allows disposal activity under carefully regulated conditions. Two major conditions are that solid waste comes to the site from only the Tri-Cities area, and that Oakland Scavenger Company operate the site for only so long as the company's franchise is approved by the City. The current franchise expires in 1981.

There is ample evidence to indicate that the amount of solid waste being generated each year by modern society is increasing, as disposable products are becoming more common. The ever-growing population of the Tri-Cities area will add to the burden. Because the current disposal site has a finite life span, other disposal sites will have to be found.

In 1972, the Alameda County Planning Commission was charged with the task of coordinating a county-wide solid waste management plan, in accordance with State law requiring such planning. The project is being funded in part by EPA. A technical advisory committee composed of representatives of the county, cities within the county, industry representatives and public agency representatives has been formed and is meeting on a regular basis. The committee has the task of preparing the plan, holding public hearings, etc. Ultimately, a comprehensive plan for solid waste management will emerge, which is intended to meet disposal needs of the entire county for the foreseeable future. The City of Fremont is represented on this committee.

Liquid Waste: Liquid waste or sewage is collected and treated by Union Sanitary District. Treated liquid wastes are passed onto the Bay through Mud and Newark Slough and Alameda Creek. Existing sewers are sized to serve a population of about 450,000 in the Tri-City area. However, within the last year, it has been determined that two of the three treatment plants are operating near capacity. So the number of new service connections will be severely limited.

The District has also been a participant in a regional study of water quality management, which has been completed, by the East Bay communities and districts involved. The study provides several possible alternative regional disposal systems which seek to meet various system objectives and criteria? the final recommended system would combine facilities from Fremont to Oakland and release effluent at a point in the center of the Bay west of the Oakland International Airport. The new system will also allow a higher degree of treatment, and will provide the foundation for a waste water reclamation program. It is expected that much of the cost will be defrayed by State and Federal facilities grants-in-aid. This recommended system will provide for the needs of the East Bay region throughout the anticipated future, and will also permit a much higher degree of water quality management.

Waste water reclamation is an important factor considering the limitations on water supply that may exist by the year 2000.

ENVIRONMENTAL CONSTRAINTS

The Conservation Element presents information in written form and also graphically. Map 8 represents a summary of the other maps that includes areas where particular concerns that may affect future land use have been identified. Each constraint represents an area of severe conflict between the natural environment and urban uses, where a change in the environment is an issue.

In Fremont's case, the components are as follows:

1. All lands with a soil capability classification of VII or VIII;
2. All lands having natural slopes in excess of 29%;
3. Earthquake fault and fault trace corridors, and known areas of existing or potential landslide hazard; (not shown on Map 8)
4. All major flood control facilities, including Alameda Creek, temporary ponding areas, and permanent flood control ponds (such as Lake Elizabeth);
5. Identified ground water recharge areas — primarily the recharge pits in the Niles District and along Alameda Creek;
6. All natural stream corridors in the hill areas (Mill Creek, etc.);
7. All lands below elevation 10 feet Mean Sea Level;
8. Existing quarry sites (until complete rehabilitation occurs);
9. The National Wildlife Refuge, which encompasses unbuildable lands;
10. All areas of significant rare or endangered plant or animal habitat, and all natural woodland areas in the City (particularly in the hill areas).

Generalized Recommendations and Implementation: (See full conservation data base for more specific recommendations.)

1. The information contained in this element and related information obtained in the future should be used as a basic data source in evaluating future City plans and development proposals, particularly through the Environmental Impact Review process.

2. The City should sponsor a complete, detailed geologic study of its territory at the first opportunity.
3. A continuing effort should be made to keep information on Fremont's plant and animal life complete and up to date.
4. The City and the Water District should establish a joint committee to consider the long range issues raised by this report.
5. A similar joint committee should be established between the City and the Flood Control District.
6. The City should continue to support the programs of the Sanitary District to link its system to a regional system.
7. The Open Space Element should aim to use open space as a means of dealing with environmental constraints. The Open Space Element should investigate and develop programs for implementation such as acquisition land-banking, zoning, easements and target planning that are based on, among other things, the Conservation Element's environmental constraints.
8. Efforts should continue to regulate the extraction of sand, gravel and stone, and the future of this industry in Fremont should be the subject of further study.
9. Local salt production should be encouraged, and conversion of salt ponds to urban uses should be resisted when and if salt production ceases.
10. The City should continue to cooperate with other agencies in regard to air pollution control and transit facilities, while reducing emphasis on automobiles within the City.

CONSERVATION ELEMENT

INTRODUCTION

This report, and accompanying maps, is the basic data, information and recommendations of the Conservation Element of the General Plan of Fremont. This Conservation Element, together with the Open Space Element, has the purpose of specifically integrating environmental considerations into the City of Fremont's planning process to insure that sufficient attention is given to the intrinsic needs of the environment, as well as to the probable effects of urban growth and development on the City's environment.

The report deals with a variety of environmental considerations: water resources, plant and animal life, air resources and the resources of land, at and below its surface. In some cases, specific information is provided; in others (where existing data is limited or lacking), suggestions for further analysis are made. Recommendations for using the Element are also included. The work that is presented here is an initial step in continuing appraisal of environment matters and will serve as a foundation for further work in this area.

LEGAL REQUIREMENTS

As noted previously, state law outlines the required content of both the Conservation Element and the Open Space Element. Section 65302, Government Code, states that the Conservation Element must deal with the "the conservation, development and utilization of natural resources including water and its hydraulic force, forests, soils, rivers and other waters, harbors, fisheries, wildlife, minerals and other natural resources." It may also deal with reclamation, flood control, pollution control, erosion prevention, land use, and sand and gravel resources. Section 65560, Government Code, identifies open space (within the Open Space Element) as "any parcel or area of land or water which is essentially unimproved and devoted to an open-space use." Four types of open space are noted: (1) open space for the preservation of natural resources, (2) open space used for the managed production of resources, (3) open space for outdoor recreation, and (4) open space for public health and safety. The close relationship between the Conservation Element and the Open Space Element is obvious; in fact, open space designations can clearly be used as a means to protect or manage areas determined as important by the Conservation Element. State law requires that the Conservation Element be prepared and adopted no later than December 31, 1973.

PURPOSE OF THE ELEMENT

Fremont is a city that presents a variety of environmental conditions - varied topography, baylands, seismic activity, water and mineral resources, plant and animal life. While planning efforts in

the past have recognized many of these conditions, the lack of an environmental data base has often hindered an indepth analysis of prospective development. The purpose of the Element is to build into the General Plan those vital considerations of environment which have not been given due consideration since its inception.

The natural environment of Fremont is a given; it must be reckoned with. Designating an area for one urban use or another does not insure that this use can indeed be placed there. It is the function of the Conservation Element to examine environmental considerations and determine which areas can or ought not to be subjected to urbanization. There is little doubt that this purpose reflects the intent of the state laws which mandate preparation of the Conservation Element.

GOALS AND OBJECTIVES OF THE ELEMENT

The previous section has briefly described the rationale for and purpose of the Conservation Element. From that purpose, there can be extracted a set of goals — general concepts of what the Element should accomplish.

These goals meet the general requirements of state law; more importantly, they represent a public recognition of the potential role of the City in preventing future environmental problems and eliminating those which presently exist. These goals will also serve as a foundation for more detailed objectives of the Element.

Conservation Element Goals

1. Modifications of the current state of the environment shall require careful justification.
2. Irrevocable allocation of limited environmental resources shall be carefully regulated in the interests of future generations.
3. The City shall use environmental resources not only in its own interests, but shall also cooperate with and assist in meeting the needs of regional, state and national constituencies in their efforts to achieve certain environmental qualities.

The above three major goals represent a range of concerns. It is clear that as goals, they can be modified to meet the needs of the City, but it should be emphasized that these goals reflect broad concerns that cannot be ignored. From these goals, there can be extracted more specific objectives and principles. Together with the data base, these goals, objectives and principles will lead to specific recommendations.

Conservation Element Objectives

1. The City of Fremont should seek to fully understand the conditions of its environment through research, study and exploration, and should not take major actions affecting the quality of the environment without such understanding.
2. Major physical attributes of the City should be preserved in the interests of providing a varied and stimulating urban environment.
3. Where environmental constraints clearly prohibit development or render it only marginally feasible, alternative uses for lands should be determined.
4. Natural resources of a rare or unique character should be protected from intrusion of incompatible uses in the interests of preserving them for present and future use.
5. Both direct and indirect benefits and costs of natural resources use should be considered prior to such use; this evaluation should be comprehensive and systematic, should consider alternative uses, and should follow a well-defined format (e.g., benefit-cost study).
6. Justification for natural resources exploitation should not be based solely on the needs of the moment, but should consider resource needs for at least 25 years into the future.
7. If permanent use of natural resource areas for development purposes cannot be clearly justified, these areas should be set aside for disposition in the future, if and when it is justified by the community at that time.
8. Prior to decisions permanently affecting major natural resources, the City should determine the effects of these decisions on the larger regional community which may also have an interest in the use of such resources.
9. The City should continue efforts at educating the public about the character and needs of the environment; these efforts can be both formal ones (e.g., through the public school system) and informal (e.g., through public recreational programs).
10. Specific efforts should be made to protect and preserve the following resources:
 - a. Highly productive agricultural areas;
 - b. Air sheds and watersheds, in their natural functioning states;
 - c. Significant, rare or endangered plant and animal species and habitats;

- d. The intrinsic variety and complexity of local ecological systems;
- e. Scenic or vista resources, including scenic drives;
- f. Bayshore lands and wildlife habitat associated with the Bay;
- g. Woodlands, marshes, and streams in their natural state.

- 11. The City should make every reasonable effort to determine how the people who live within its boundaries feel about their environment and consider these feelings in environmental planning.

CONSERVATION DATA BASE

The Conservation data base will present the following components: analyses of land, water, mineral, ecological and air resources; definition of environmental constraints imposed by the natural character of the City on potential development efforts; and general recommendations which deal with fundamental decisions that the City has yet to make. Many concerns and proposals will be expressed on maps.

The Data Base is intended to serve as an ongoing information source on which to base decisions about the preservation of open space in the City and from which can arise basic policy about the most reasonable development patterns that the City can follow. It is intended primarily to make the decision-making process in the City more informed and rational through the provision of necessary information of an environmental nature. It is designed to be used immediately and throughout the foreseeable future, and should be improved and updated as time passes in order that it will reflect the current state-of-the-art of environmental analysis.

LAND RESOURCES

Introduction

The shape, form and function of the city is generally dictated by the constraints placed on it by the land; related activities, including recreation and food production, are also influenced by the land.

For purposes of this discussion, land resources can be defined as the natural elements that make up the surface of the earth and the area beneath the surface; geologic structure, soils, topography, and seismic conditions. Information on these subjects can then be used in conjunction with the other chapters of the Element to derive an understanding of which areas of the City can support urbanization and which cannot, and how resources should be managed throughout the years to come. The information will range from generalized to specific, depending on available data, and will serve as the foundation for subsequent recommendations.

Geology

A general survey of the geologic structure and history of the Fremont area can contribute to an overall understanding of environmental conditions, and serve as a foundation for examination of other, more detailed (such as soils) information. Geology is the science of the earth's structure; it relates to planning in many ways, from allowing an evaluation of surface resources and their needs, to providing information on seismic hazards which directly affect urban development. At the present time, detailed geologic data for Fremont is not available, but generalized information does exist and will be used here. A United States Geological Survey Generalized Geology Map is presented in Figure One.

General Physical Makeup

Fremont is located on a broad alluvial plain made up of sediments deposited over the underlying bedrock by millennia of erosive action by water flowing from the hills down toward the Bay basin. The plain ranges in elevation from sea level at the Bay to about 100 feet MSL at its eastern periphery where it meets the hills. The alluvium reaches depths of about 800 feet, and is composed of layers of silty and clayey sediments alternated by layers of sand and gravel. These latter deposits form aquifers from which much of the groundwater for the Fremont basin was withdrawn during the past decades (see Water Resources chapter). The basin itself includes the Bay, reaching beneath it to the San Francisco peninsula. The surface of this alluvium is composed of rich soils which historically have supported a variety of natural and cultivated plant life.

Prepared in cooperation with
DEPARTMENT of HOUSING and URBAN DEVELOPMENT
AND
ASSOCIATION of BAY AREA GOVERNMENTS

U.S. GEOLOGICAL SURVEY OPEN FILE MAP

EXPLANATION

1 

Mud

2 

Unconsolidated sediments

3 

Moderately consolidated to
well-consolidated sedimentary
rocks

4 

Volcanic rocks

5 

Franciscan assemblage
KJf - sandstone and shale
chert, metamorphic rocks,
limestone, sheared rocks
(melange)

KJv - volcanic rocks

6 

Sandstone, shale, and
conglomerate; locally
in oldest part basaltic
volcanic rock and chert

7 

Serpentine and
peridotite

8 

Granitic rocks

AGE
QUATERNARY

TERTIARY

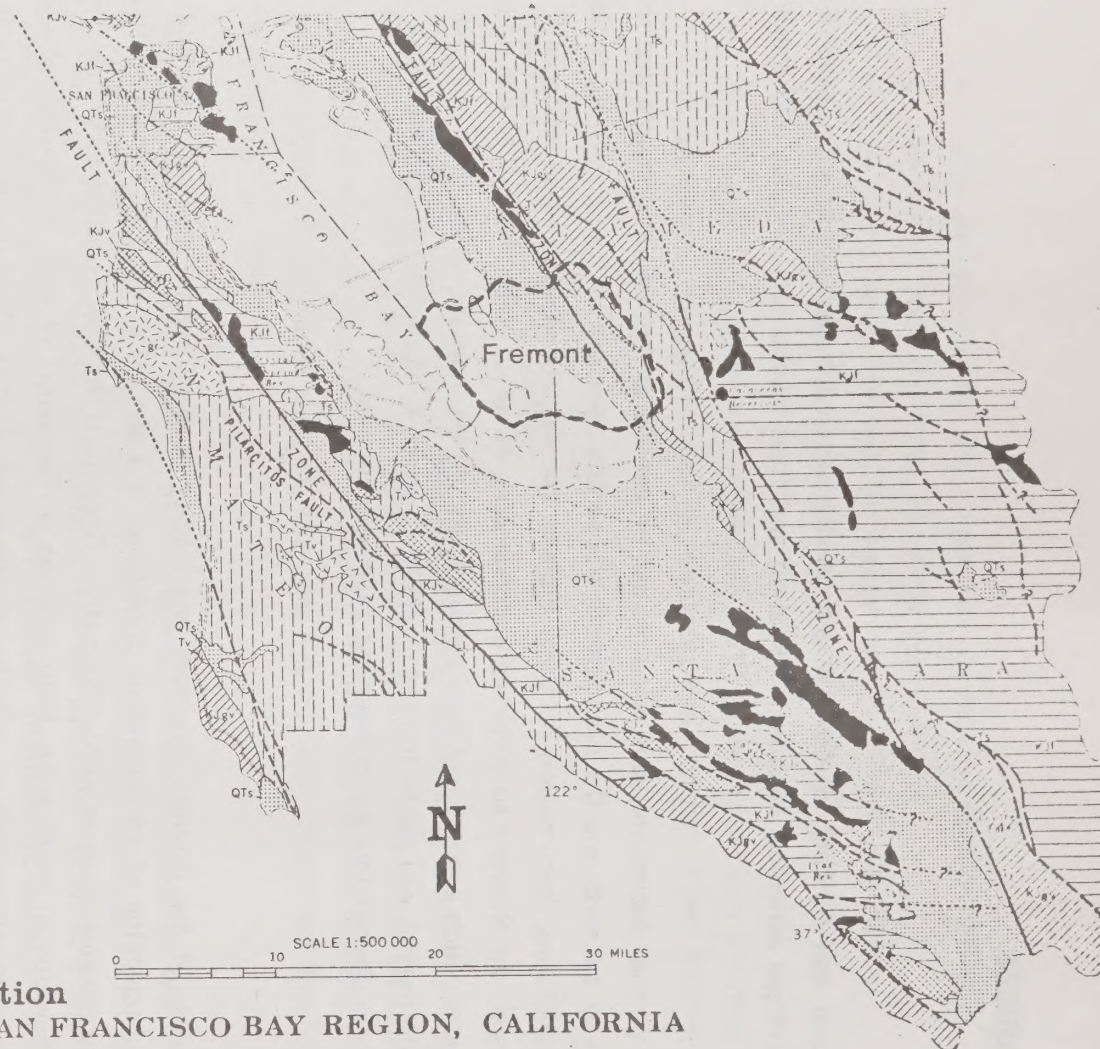
JURASSIC AND
CRETACEOUS

Contact
Dashed where
approximately
located

Fault known to be active
Dotted where concealed

Fault not known to be active
Dotted where concealed Only selected
faults shown. Query indicates
uncertainty as to existence of fault

FOR MORE DETAILED EXPLANATION OF MAP UNITS
SEE APPENDIX A.



Portion GENERALIZED GEOLOGIC MAP OF THE SAN FRANCISCO BAY REGION, CALIFORNIA

by J. Schlocker

1970

Geology compiled by J. Schlocker and Kenneth C. Crowther 1967,
mostly from Geologic map of California, Olaf P. Jenkins Edition,
San Francisco, Santa Rosa, Sacramento, San Jose, and Santa
Cruz sheets published by the California Div. of Mines and
Geology, 1958 to 1966; and from U.S. Coast and Geodetic Survey
maps and field sheets of surveys of San Francisco Bay of
1950 and later.



This map is preliminary and has not
been reviewed for conformity with
U.S. Geological Survey standards
and nomenclature.

FIGURE 1

The bedrock surface rises sharply beneath the City's hill areas, which make up the westernmost portion of the Diablo Range of mountains that extends the length of the Bay on its eastern shore (these hills are also known as the Mission Hills, the Front Hills, and the Berkeley Hills) and separates the Bay from the San Joaquin Valley. No detailed survey of the Fremont portion of the range is available; however, related information¹ concerning other parts of the range indicates that the hills are made up of materials dating from the Jurassic to Cretaceous ages — 70 to 180 million years past — known as the Franciscan assemblage. The assemblage is a complex of sedimentary, volcanic and metamorphic rocks and limestone. More recent materials, dating from 3 to 40 million years old, are also found in the hills; these consist of moderately-to well-consolidated rocks including sandstone, shale, siltstone, conglomerate, chert, porcellanite, coal, limestone, agglomerate and tuff. These materials often contain deposits of coal, sand, commercial clay and petroleum, and are known to have a poor bearing capacity tending to slump badly on slopes steeper than 2 to 1. They overlay the older formations, along with smaller sections of serpentine and peridotite materials which occur along the Hayward Fault.

A second older formation found in the hills dates from the same era as the Franciscan assemblage. It is composed of sandstone, shale and conglomerate, plus basaltic volcanic rock and chert in certain areas. According to the U.S.G.S. map, this formation is similar in character to the Franciscan; both make up the bulk of the hills. The Coyote Hills in Fremont are also composed of Franciscan materials.

The surface of the hills is made up of weathered rocks; much of the soil thus produced has eroded away through wind and water action into the alluvium below in the Bay plain, leaving only a thin coating of relatively poor quality soil covering the rocks. The process is still going on, and will continue to do so unless changing climatic or topographic conditions halt or modify it.

Geologic Forces

Few problems of a geologic nature (other than seismic) are likely to occur in the flatlands,² since these lands are made up of deep layers of alluvium and bedrock lies far below. In the hill area, however, are certain conditions which can present problems to human activities, particularly urban land development. Among these problems is soil creep, which occurs when the surface of the land is pushed or moves downslope due to the weight of water or of grazing cattle. Water is introduced by precipitation, irrigation or septic tank fields, and large amounts of it on steep slopes can result in large-scale creep of surface soils downward, especially if the subsurface structure is lubricated excessively by moisture. Creep can accelerate into wholesale land slippage, including landslides, when conditions become severe enough. These phenomena most often occur where the underlying material is unstable or is of a type easily weathered, either

through exposure to the elements (as in excavations or grading activity), or through entry of water as noted above. Debris flows are most common in areas underlain by shale, since shale weathers more rapidly than sandstone or conglomerate.

In the hills of East San Jose, which have a makeup similar to the Fremont hills, numerous landslide damage has been noted by U.S.G.S. In the "San Jose Highlands" subdivision, economic loss as a consequence of development on landslide deposits has been great. The estimated 1969-1970 loss in market value for all houses in San Jose Highlands was \$228,000; the loss for lots was \$195,000; and the loss in valuation for specific landslide damage to certain houses was \$61,520 — a total loss of \$484,520. The San Jose Department of Public Works spent \$760,500, 1968-71, in maintenance work in the San Jose Highlands.³ These costs reveal the magnitude of expenses to the municipality as well as the individual homeowner when landslide activity takes place within a subdivision area.

Other forces and actions can contribute to unstable geologic conditions. A sudden change — either natural or manmade — in surface environmental conditions can trigger land movement. For example, the removal of trees and large shrubs, which have deep root systems that tend to stabilize land, can accelerate soil creep and produce more spectacular actions. Overgrazing can reduce plant cover to the point where creep occurs, both through the weight of livestock on the land and through the creation of small shelves and perforations where water can easily enter the soil and accelerate slippage.

These factors in geologic makeup of the hill area presents several problems to intensive land use. Less obvious, but equally damaging, forces such as wind or water induced sheet erosion of exposed land can produce large quantities of silt which move to the flatlands, settling in drainage systems and natural watercourses alike. The removal of natural plant cover (removal generally accompanies urban development) can produce serious problems. Because the hills are composed of ancient rock formations with little alluvial material within them, the possibilities of tapping groundwater deposits are limited; although deposits are likely present throughout the formations, locating them in a quantity large enough to serve a number of dwelling units (or irrigated fields) is difficult and costly. Water would have to be piped to these areas if it were needed in large quantity. And, of course, added water in the hills could produce more of the side-effects cited above.

These constraints are common throughout the hills, but are most critical in areas of steep slopes (over 25% to 30%, or a 1:4 to 1:3 incline), where any type of development, whether for streets or buildings, will require large amounts of grading, removal of plant cover, etc. The steeper the slope, the more the risk of soil movement (particularly in times of seismic action). The forces and cause-effect relationships which affect land stability in the hills are complex, but most often exert their strongest influence on slopes. A later section of this chapter will discuss slopes in more detail, and will present recommendations for dealing with various degrees of slopes; at the present time, some basic recommendations involving not only slopes but geologic study can be

made. Some of these recommendations are extracted from those made in the "Hayward Hill Area Study" cited earlier.

Geologic Recommendations

1. The City should, at the first opportunity, sponsor a complete, detailed geologic study of its territory, with particular reference to the hills, to determine the precise nature of the geologic structure and its implications for various types of land use on an area-by-area basis within the City.
2. Land use activity involving modification of the land surface should be strictly regulated and in questionable cases prohibited until a geologic study provides guidelines for land use.
3. Any changes in the existing natural system of balances in the hills should be disallowed, since they could result in serious environmental problems. These changes could include grading, removal of plant cover, introduction of large amounts of water, overgrazing (except during the dry season), and exposure of open soil or rock.
4. A City-wide geologic study notwithstanding, any development proposals in the hills should be accompanied, by City ordinance, with a comprehensive on-site geologic study assessing not only those actions needed to carry out the proposals but determining the short and long term effects of the proposal upon the geologic structure and stability of the hills.

Many of the above recommended actions are implicit in the state required Seismic Safety Element study which the City will be undertaking in the future. Until that time, development which threatens the natural stability of the land should not be permitted, and that which appears to be hazardous under certain conditions should be closely examined. Authority already exists in City ordinance for requiring on-site soils surveys in connection with subdivisions, building permits and grading permits, when deemed necessary.

Soils

The relatively thin layer of weathered rock, organic matter and sediment which make up soils has the most direct implications for land use of any single natural characteristic of the environment. Certain types of soils are eminently suited to carry the loads imposed by urban-type developments; other types will not tolerate those loads and are best used for nonurban purposes. Soils are a vital natural resource, serving as sole producer of the world's land-based food supply, and can be dealt with as a resource to be protected and used. Few other natural resources have such



FREMONT GENERAL PLAN CONSERVATION ELEMENT

SOILS

LEGEND

BOUNDARIES OF SOIL DIFFERENCES

BOUNDARY OF DETAILED SOIL SURVEY.

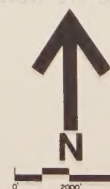
AmE2 - Altamont Clay	LaE2 - Linne Clay Loam
AzD - Azule Clay Loam	LcF2 - Linne Clay Loam
Cc - Clear Lake Clay	LoE2 - Lobitos Shaly Loam
CdA - Clear Lake Clay, Drained	LpE2 - Los Gatos - Los Osos Complex
CdB - Clear Lake Clay, Drained	LpF2 - Los Gatos - Los Osos Complex
CoC2 - Cotati Fine Sandy Loam	LtD - Los Osos Silty Clay Loam
DaA - Danville Silty Clay Loam	LtE2 - Los Osos Silty Clay Loam
DaB - Danville Silty Clay Loam	LtF2 - Los Osos Silty Clay Loam
DbD - Diablo Clay	LuD - Los Osos and Millsholm
DbE2 - Diablo Clay	LuE2 - Los Osos and Millsholm
DmF2 - Diablo Clay	MhE2 - Millsholm Silt Loam
DvC - Diablo Clay	MhF2 - Millsholm Silt Loam
DvD2 - Diablo Clay	Pd - Pescadero Clay
DvF2 - Diablo Clay	Rh - Riverwash
GaE2 - Gaviota Rocky Sandy Loam	RoF - Rock Land
GaF2 - Gaviota Rocky Sandy Loam	VaF2 - Vallecitos Rocky Loam
Gp - Gravel Pit	YmA - Yolo Loam
LaD - Linne Clay Loam	YmB - Yolo Loam

GENERALIZED SOIL SURVEY

CM - Clear Lake Association
cp-Rn - Cropley Rincon Association
BC - Cropley Rincon Association
cv-LF-F-2 - Climara Los Osos Association
DI-An-DE-2 - Diablo Altamont Association
PP - Gravel Pits
Rn-Zm - Rincon Zamora Association
Sp-Cv - Sunnyvale Castro Association
TZ - Tidal Flats
Yo-sb - Yolo Sorrento Sycamore (drained) Association
Sy - Sycamore Association

CITY OF NEWARK

FREMONT CITY BOUNDARY



MAP 1

SOURCE: U.S. SOIL CONSERVATION SERVICE

THIS MAP IS ONE OF SEVERAL WHICH ACCOMPANY THE TEXTUAL MATERIALS OF THE CONSERVATION ELEMENT IN THE FREMONT GENERAL PLAN. IT IS INTENDED TO ILLUSTRATE THE CONCEPTS AND PROPOSALS OF THE OF THE ELEMENT, AND SHOULD BE USED FOR GENERAL PLANNING PURPOSES ONLY. PRECISE PLANNING DATA MUST BE USED TO SUPPLEMENT THIS INFORMATION AT THE TIME OF PLAN IMPLEMENTATION.

a direct bearing on the affairs of men, whether it be to provide land for growing crops or land on which to build cities.

This discussion will include analyses of local soils types, their properties, implications of each for various types of land use, and recommended actions for guiding land use within the City which will most accurately reflect the nature of the City's soil resource base. Information produced in this process can then be coupled to other land resources data to derive conclusions on the nature of the land related environment and its role in the future of the City.

The Soil Conservation Service of the U.S. Department of Agriculture is charged with the generation of information on the nation's soils. Traditionally, the SCS produced data which was oriented toward nonurban use of the land, but in recent years, it has become involved in producing information useful to urban planning. Fremont is included in the Livermore-based Resource Conservation District, which has published two major reports on soils in the City,⁴ and is currently developing a third. The first report is a detailed soils survey of eastern Alameda County, which includes the hill area of Fremont (the approximate boundary is along Mission Boulevard); the second report is a generalized survey for the entire county. The third, upcoming report will provide detailed data for that area left out of the first detailed report noted above.

Data provided by the SCS is presented in Tables One through Three and on Map One. Table One gives a general description of the properties of various soil types. Properties may be defined as those natural attributes which give soil its character and capabilities. The table also indicates major occurring soils and minor occurring soils which indicates the relative magnitude of each in the City. Table Two applies the same sequence of soil types and symbols to a group of interpretations of the properties for various kinds of land uses — these interpretations are judgments about the implications of each soils type for exposing the soil (as in grading), installing septic sewer systems, building dwellings, etc. Both sets of data were provided by the SCS, from its reports and through direct consultation with District staff. These tables are concerned with conditions in the hill area only, since they were derived from the detailed survey.

Table Three contains information on both properties and interpretations of soils associations in the flatland portion of the City. Because the data source is the generalized survey (plus consultation with SCS officials), the information is generalized to the extent that most soils types are not broken out as they were in Tables One and Two. Map One presents graphic information indicating where both detailed and generalized soils are located within the City. At a time when the impending SCS detailed survey for the flatlands is complete, the information can be integrated into both the tabular and mapped data.

Because of limitations of time and space, it is not possible to provide a highly detailed discussion of each element presented in all three tables and the relations and implications of the elements

to one another and to the City. However, it is useful to provide a summary description of the major points evident in the tables, to allow an analysis and recommendations to be made. If more specific information is required, the soil survey reports cited earlier should be consulted.

Table One contains a number of properties of each soil type. It also indicates the "capability class" of each type, which is an index involving a number of considerations that effect the usefulness of the soil for agricultural purposes. The SCS describes its capability classes as follows:

LAND SUITED FOR CULTIVATION AND OTHER USES

- Class I** — Soils in Class I have few limitations that affect their use.
- Class II** — Soils in Class II have some limitations that reduce the choice of plants or require moderate conservation practices.
- Class III** — Soils in Class III have severe limitations that reduce the choice of plants or require special conservation practices or both.
- Class IV** — Soils in Class IV have very severe limitations that restrict the choice of plans, require very careful management, or both.

LAND GENERALLY NOT SUITED FOR CULTIVATION

- Class V** — Soils in Class V have little or not erosion hazard but have other limitations that are impractical to remove.
- Class VI** — Soils in Class VI have severe limitations that make them generally unsuited for cultivation.
- Class VII** — Soils in Class VII have very severe limitations that make them unsuited for cultivation.
- Class VIII** — Soils and land forms in Class VIII have limitations that preclude their use for commercial plant production and restrict their use to recreation, for wildlife, water supply, or aesthetic purposes.⁵

SOIL PROPERTIES

TABLE ONE

		SOIL SYMBOL - NAME	CAPA- BILITY CLASS	% SLOPE	EFFECTIVE DEPTH	NATURAL DRAINAGE	SUBSOIL PERME- ABILITY	SHRINK- SWELL POTENTIAL	NATURAL FERTILITY	AVAILABLE WATER HOLD- ING CAPACITY
MAJOR OCCURRING SOILS	danville	DaA - Danville Silty Clay Loam	II	0 - 3	Very Deep	Good	Slow	Moderate	High	High
		DaB - Danville Silty Clay Loam	II	3 - 10	Very Deep	Good	Slow	Moderate	High	High
	diablo	DvC - Diablo Clay	III	3 - 15	Deep	Good	Slow	High	High	High
		DvD2 - Diablo Clay	IV	15 - 30	Deep	Good	Slow	High	High	High
		DvF2 - Diablo Clay	VII	45 - 60	Deep	Good	Slow	High	High	High
	gaviota	GaE2 - Gaviota Rocky Sandy Loam	VI	5 - 40	Shallow	Somewhat Excessive	Moderately Rapid	Low	Low	Very Low
		GaF2 - Gaviota Rocky Sandy Loam	VII	40 - 75	Shallow	Excessive	Very Rapid	Low	Low	Very Low
	linne	LaD - Linne Clay Loam	IV	15 - 30	Moderately Deep	Good	Moderately Slow	Low	High	Moderate
		LaE2 - Linne Clay Loam	VI	30 - 45	Moderately Deep	Good	Moderately Slow	Low	High	Moderate
		LcF2 - Linne Clay Loam	VII	45 - 75	Shallow	Good	Moderately Slow	Low	High	Low
	lob- itos	LoE2 - Lobitos Shaly Loam	VI	9 - 45	Very shallow to Moderately Deep	Good	Moderate	Low	Low	Low
	los gatos	LpE2 - Los Gatos - Los Osos Complex	VI	30 - 45	Shallow to Moderately Deep	Good	Moderate	Low	Low to Moderate	Low to Moderate
		LpF2 - Los Gatos - Los Osos Complex	VII	45 - 75	Shallow to Moderately Deep	Good	Moderate	Low	Low to Moderate	Low to Moderate
	los osos	LtD - Los Osos Silty Clay Loam	IV	7 - 30	Moderately Deep	Good	Moderately Slow	Moderate	Moderate	Low to Moderate
		LtE2 - Los Osos Silty Clay Loam	VI	30 - 45	Moderately Deep	Good	Moderately Slow	Moderate	Moderate	Low to Moderate
		LtF2 - Los Osos Silty Clay Loam	VII	45 - 75	Moderately Deep	Good	Moderately Slow	Moderate	Moderate	Low to Moderate
		LuD - Los Osos and Millsholm	IV	7 - 30	Moderately Deep	Good	Moderate to Moderately Slow	Moderate	Low to Moderate	Low to Moderate
		LuE2 - Los Osos and Millsholm	VI	30 - 45	Moderately Deep	Good	Moderate to Moderately Slow	Moderate	Low to Moderate	Low to Moderate
	MILL- SHOLM	MhE2 - Millsholm Silt Loam	VI	30 - 45	Shallow	Good	Moderate	Moderate	Low	Low

TABLE ONE

MAJOR cont.	SOIL SYMBOL - NAME	CAPA- BILITY CLASS	Z SLOPE	EFFECTIVE DEPTH	NATURAL DRAINAGE	SUBSOIL PERME- ABILITY	SHRINK- SWELL POTENTIAL	NATURAL FERTILITY	AVAILABLE WATER HOLD- ING CAPACITY
MINOR OCCURRING SOILS	MhF2 - Millsholm Silt Loam	VII	45 - 75	Shallow	Good	Moderate	Moderate	Low	Low
	YmA - Yolo Loam	I	0 - 3	Very Deep	Good	Moderate	Low	Moderate	High
	YmB - Yolo Loam	II	3 - 10	Very Deep	Good	Moderate	Low	Moderate	High
	AmE2 - Altamont Clay	VI	30 - 45	Moderately Deep	Good	Slow	High	Moderate	Moderate
	AzD - Azure Clay Loam	IV	3 - 30	Moderately Deep	Good	Slow	High	Moderate	Moderate
	Cc - Clear Lake Clay	III	0 - 3	Deep	Imperfect	Slow	High	High	High
	CdA - Clear Lake Clay, Drained	III	0 - 3	Very Deep	Moderately Good	Slow	High	High	High
	CdB - Clear Lake Clay, Drained	III	3 - 7	Very Deep	Moderately Good	Slow	High	High	High
	CoC2 - Cotati Fine Sandy Loam	IV		Moderately Deep	Imperfect	Slow	Low to High	Low	Low
	DbD - Diablo Clay	IV	15 - 30	Deep	Good	Slow	High	High	Moderate
	DbE2 - Diablo Clay	VI	30 - 45	Deep	Good	Slow	High	High	Moderate
	DmF2 - Diablo Clay	VII	45 - 60	Moderately Deep	Good	Slow	High	Moderate	Low
	Gp - Gravel Pit	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	Pd - Pescadero Clay	VI		Moderately Deep	Imperfect	Very Slow	Moderate to High	Low	Low
	Rh - Riverwash	VIII	N/A	N/A	N/A	N/A	Low	N/A	N/A
	RoF - Rock Land	VIII	N/A	N/A	Excessive	N/A	N/A	Low	N/A
	VaF2 - Vallecitos Rocky Loam	VII	45 - 75	Shallow	Excessive	Moderately Slow	Low	Low	Low

TABLE TWO

INTERPRETATIONS OF SOIL PROPERTIES AS
URBANIZATION CONSTRAINTS

		SOIL SYMBOL - NAME	EROSION HAZARD	FOR SEPTIC TANKS*	FOR DWELLINGS*	FOR STREETS*	FOR SHALLOW EXCAVATIONS*
MAJOR OCCURRING SOILS	danville	DaA - Danville Silty Loam	Slight	Severe (1)	Moderate (3)	Moderate (3)	Slight to Moderate (2)
		DaB - Danville Silty Loam	Slight to Moderate	Severe (1)	Moderate (3,4)	Moderate (3)	Moderate (2,4)
	diablo	DvC - Diablo Clay	Slight to Moderate	Severe (1)	Severe (3)	Severe (3)	Severe (2)
		DvD2 - Diablo Clay	Moderate	Severe (1,4)	Severe (3,4)	Severe (3,4)	Severe (2,4)
		DvF2 - Diablo Clay	Very Severe	Severe (1,4)	Severe (3,4)	Severe (3,4)	Severe (2,4)
	gaviota	GaE2 - Gaviota Rocky Sandy Loam	Slight to Severe	Severe (4,5)	Severe (4,5)	Severe (4,5)	Severe (4,5)
		GaF2 - Gaviota Rocky Sandy Loam	Very Severe	Severe (4,5)	Severe (4,5)	Severe (4,5)	Severe (4,5)
	linne	LaD - Linne Clay Loam	Moderate	Severe (1,4,5)	Severe (4)	Severe (4)	Severe (4)
		LaE2 - Linne Clay Loam	Severe	Severe (1,4,5)	Severe (4)	Severe (4)	Severe (4)
		LcF2 - Linne Clay Loam	Very Severe	Severe (1,4,5)	Severe (4)	Severe (4)	Severe (4)
	lob- gatos	LoE2 - Lobitos Shaly Loam	Moderate to Severe	Severe (4,5)	Moderate to Severe	Moderate to Severe	Severe (4,5)
		LpE2 - Los Gatos - Los Osos Complex	Severe	Severe (4,5)	Severe (4)	Severe (4)	Severe (4)
		LpF2 - Los Gatos - Los Osos Complex	Very Severe	Severe (4,5)	Severe (4)	Severe (4)	Severe (4)
	los osos	LtD - Los Osos Silty Clay Loam	Moderate	Severe (1,4)	Moderate to Severe (4)	Moderate to Severe (4)	Moderate Severe (4)
		LtE2 - Los Osos Silty Clay Loam	Severe	Severe (1,4)	Severe (4)	Severe (4)	Severe (4)
		LtF2 - Los Osos Silty Clay Loam	Very Severe	Severe (1,4)	Severe (4)	Severe (4)	Severe (4)
		LuD - Los Osos and Millsholm	Moderate	Severe (4,5)	Moderate to Severe (4)	Moderate to Severe (4)	Moderate to Severe (4)
		LuE2 - Los Osos and Millsholm	Severe	Severe (4)	Severe (4)	Severe (4)	Severe (4)
	mill- sholm	MhE2 - Millsholm Silt Loam	Severe	Severe (4,5)	Severe (4)	Severe (4)	Severe (4,5)
		MhF2 - Millsholm Silt Loam	Very Severe	Severe (4,5)	Severe (4)	Severe (4)	Severe (4,5)
	yolo	YmA - Yolo Loam	Slight	Slight (6)	Slight (6)	Slight (6)	Slight (6)
		YmB - Yolo Loam	Slight to Moderate	Slight (6)	Slight (6)	Slight (6)	Slight (6)

TABLE TWO

MINOR OCCURRING SOILS	SOIL SYMBOL - NAME	EROSION HAZARD	FOR SEPTIC TANKS*	FOR DWELLINGS*	FOR STREETS*	FOR SHALLOW EXCAVATIONS*
	AmE2 - Altamont Clay	Severe	Severe (1,4,5)	Severe (3,4)	Severe (3,4)	Severe (4,5)
	AzD - Azure Clay Loam	Slight to Moderate	Severe (1)	Moderate to Severe (3,4)	Moderate to Severe (3,4)	Severe (2,4)
	Cc - Clear Lake Clay	Slight	Severe (1,7)	Severe (3,8)	Severe (3)	Severe (2,8)
	CdA - Clear Lake Clay, Drained	Slight	Severe (1)	Severe (3)	Severe (3)	Severe (2)
	CdB - Clear Lake Clay, Drained	Slight	Severe (1)	Severe (3)	Severe (3)	Severe (2)
	CoC2 - Cotati Fine Sandy Loam	Slight to Moderate	Severe (1)	Severe (3)	Severe (3)	Severe (2)
	DbD - Diablo Clay	Moderate	Severe (1,4)	Severe (3,4)	Severe (3,4)	Severe (2,3)
	DbE2 - Diablo Clay	Severe	Severe (1,4)	Severe (3,4)	Severe (3,4)	Severe (4)
	DmF2 - Diablo Clay	Very Severe	Severe (1,4)	Severe (3,4)	Severe (3,4)	Severe (2,4)
	Gp - Gravel Pit	N/A	N/A	N/A	N/A	N/A
	Pd - Pescadero Clay	Slight	Severe (1,6,7)	Severe (3,6,7,8)	Severe (3,6,8)	Severe (2,6,7,8)
	Rh - Riverwash	N/A	Severe (6,9)	Severe (6)	Severe (6)	Severe (6)
	RoF - Rock Land	Critical	Severe (4,5)	Severe (4)	Severe (4)	Severe (4,5)
	VaF2 - Vallecitos Rocky Loam	Very Severe	Severe (4,5)	Severe (4)	Severe (4)	Severe (4,5)

*Numbers refer to the following limitations:

1. Slowly permeable subsoil
2. Clayey textures
3. Shrink swell
4. Slope
5. Shallow soil
6. Severe - where subject to flooding
7. High water table
8. Poor drainage
9. Ground water pollution hazard

TABLE THREE

Soil Symbol & Name	Cap- ability Unit	SOIL PROPERTIES								INTERPRETATIONS OF SOIL PROPERTIES	
		% Slope	Effect. Depth In Inches	Natural Drainage	Subsoil Perme- ability	Shrink Swell Potential	Natural Fertility	Corro- sivity to Untreated Steel	Corro- sivity to Concrete	Erosion Hazard	Septic tank limitations
CM - Clear Lake Association	III	0-3	48	Somewhat Poor	Slow	High	High	Very High	Low	None	Severe
<u>cp-Rn</u> BC - Cropley Rincon Assn.	II	2-9	60+	Moderately Good to Good	Slow	High	High	Moderate to High	Low	Slight	Severe
cv-LF-F-2 - Climara- Los Osos Assn.	VI	30-50	20-36	Good	Moderately Slow	High	Moderate	Moderate to High	Low	High	Severe
Dl-An-DE-2 - Diablo Altamont Assn.	IV	9-30	36-60	Good	Slow	High	High	High	Low	Moderate	Severe
PF - Gravel Pits	N/A	N/A	N/A	N/A	N/A	N/A	N/A	Very High	Low	N/A	N/A
Rn-Zm - Rincon Zamora Assn.	I	0-3	60+	Good	Slow	Moderate to High	High	Moderate	Low	None	Moderate to Severe
Sp-Cv - Sunnyvale Castro Assn.	III	0-3	48	Somewhat Poor	Slow	Moderate	High	High	Low	None	Severe
TZ - Tidal Flats	VIII	0-3	Varies	Very Poor	Slow	High Shrink- Low Swell	Low	Very High	Very High	None	Severe
Yo-sb - Yolo-Sorrento Sycamore (drained) Association	I	0-3	60+	Good	Moderate	Moderate	High	Moderate	Low	None	Slight
Sy - Sycamore Association	II	0-3	Variable Due to Water	Somewhat Poor	Slow	Low to High	High	High	Low	None	Moderate to Severe



In general terms, the lower the Roman numeral assigned to each soils type, the more suitable the soil is for agricultural purposes. Although the land capability system is an agricultural rating, it effectively places Fremont's soils into groups that have very similar hazard characteristics for urban use. The index is extremely convenient to use, and comprehensive, since it reflects a large number of considerations. It should not pre-empt the more detailed information on properties or interpretations if such detail is called for, but can serve as a valuable guide for general decisions involving soil types and uses.

Percent slope is also shown on Table One. Soils occur on widely-ranging topography, which in turn effects the usefulness of the soil for farming and other purposes — it is an important ingredient in the capability classification. Generally, the less severe the slope, the more suitable the soil is for use, and the better the capability rating is likely to be.

Effective depth refers to the distance below the surface of the soil which can be readily penetrated by roots. "Shallow" refers to depths of 10 to 20 inches; "moderately deep," between 20 and

36 inches; "deep," 36 inches to 60 inches; and "very deep," more than 60 inches. Generally, the deeper the soil, the more suitable it is for crop production. Soil depth is incorporated into the capability classification noted above.

Natural drainage refers to the rate of removal of water from the soil under natural conditions. "Imperfect" drainage means that water is removed from the soil slowly enough to keep it wet for significant periods of time; "good" drainage indicates that soil drains readily but not too rapidly; "excessive" drainage means that the soil releases water faster than it can be used by plants growing within it.

Subsoil permeability is another drainage consideration; it refers to the amount of time required for a given amount of water to seep, or percolate, through the soil and subsoil beneath it under saturated conditions. "Slow" permeability of the subsoil indicates that water will remain in a standpipe for a long time; "moderate" means that water will seep through the subsoil more quickly, and "rapid" indicates a very high rate of seepage. Both drainage and subsoil permeability provide information on the composition of the soil: loose soil will drain quickly, while dense, packed soil will drain slowly. Both have strong implications for plant production as well as urban uses, such as septic tank fields. Both affect the capability classification.

Shrink-swell potential refers to the tendency of a soil to expand when wet and shrink in volume when dry. A high potential indicates that changing moisture conditions can markedly effect the condition of the soil surface, while a low potential indicates little, if any, effect of moisture. Most concerns about shrink-swell potential relate to urban land uses, since it has a minor effect on most agricultural or nonurban uses.

Natural fertility indicates the intrinsic ability of the soil to provide necessary plant nutrients, in proper amounts and balance, to sustain growth of plants. In this respect, it is a value indicator of the usefulness of the soil for agricultural production without the addition of artificial fertilizers (given favorable climatic and topographic conditions).

Available water holding capacity is a measure of the soil's ability to store water that is available for plant use. Soils with a high capacity to retain water will tend to be moist for longer times than those with low capacities. A tendency to hold water may lessen the need for frequent irrigation.

Soil and Urban Uses

The above paragraphs very briefly summarize a complex and interrelated set of soils properties. Each of them has its own implications for various types of land use; when combined, the ramifications become too many to be traced here. As alternatives, the capability classification

is used; as are urban interpretations of each soils type (considering all properties) for various land uses and conditions. Table Two contains these interpretations, which are explained briefly below.

Erosion hazard refers to the likelihood of soil loss through wind or water action upon removal of plant cover. A severe hazard indicates that plant cover should not be disturbed, and a slight hazard suggests that soil exposure would result in minimal erosion if normal precautions against it are taken.

Septic tank limitations relate to earlier comments on soil drainage properties, plus other considerations such as soil depth and slope. Soils which are not suitable for septic tank fields may allow effluent to surface on lower slopes.; other problems include oversaturation and pollution hazards, depending on the properties of the soil in question.

Constraints for dwelling unit and street construction are products of soil depth, slope and shrink-swell potential; grading for such development could also result in increased erosion and soil movement. A severe constraint suggests major (and costly) precautions be taken to overcome hazards while a moderate or slight one indicates that development would not be seriously hampered if normal precautions against erosion and other hazards were followed.

Since almost any kind of construction activity, especially in the hills, involves a certain amount of excavating, this constraint is an important one. It occurs most often because of soil texture or slope, and ranges from slight to severe.

The numbers in parentheses in the body of the table explain the rationales for the interpretations of the various soils types; they refer to properties such as slope, depth of the soil, shrink-swell potential, etc., and in this sense relate closely to the properties discussed in Table One. As can be seen from Table Two, certain soils have far greater constraints for urban-type uses than others. Many of these constraints are products of excessive slopes, since the detailed survey area is confined to Fremont's hills; on flatlands, the soils might present a different picture of development constraints. The question of slopes will be more completely discussed in the following section, but this analysis suggests that hill area development will be required to overcome substantial topographical and environmental conditions if it is to proceed without damaging the resource base or creating a hazard, either to the environment or to inhabitants of the City. It should also be noted, in comparing the two tables, that those soils presenting the most severe constraints for development also carry the poorest capability unit ratings; this is especially true in the hill area, where slope factors strongly influence soil capability ratings.

Table Three provides information, paralleling that of Tables One and Two, for the flatland areas of the City. Most of the factors are the same, and need no further explanation. However, there

are some differences: soil depth is expressed in inches rather than categories, and water holding capacity is not listed. Corrosivity to untreated steel and concrete is included in the properties section; this refers to the chemical makeup of the soil and the likelihood of structural forms being damaged by chemical action in the absence of appropriate protective treatment. The table indicates that untreated steel stands a much greater chance of being damaged than does concrete. Interpretive data is limited to erosion hazards and septic tank limitations; the former are slight in most cases, while the latter are generally severe.

As noted previously, Map One illustrates the locale of each soils type or association for both hill areas and flatlands. It should be used as a reference in developing future planning proposals within the City. While the map (especially in the flatlands) is not detailed enough to allow a complete analysis of soils types on a given parcel, it will provide guidance to decision makers in alerting them to possible problems relating to soils types, and give them a rationale to require further, detailed on-site soil inspections. The map can also be used as an overall resources inventory, since soils are a most important resource which, once lost, are usually gone forever.

Several references have been made to the land capability classification discussed at the beginning of this section. Because soils in the Fremont area have similar limitations for both agricultural and urban uses,⁶ certain recommendations can be based on it. To facilitate this approach, Map Two indicates the area of the City divided into capability groups alone; this map was extracted from Map One and the three tables accompanying it. As the map indicates, much of the flatland area of the City falls into the capability unit Class I and Class II designations. A large amount of Class III land is also present. In the hill areas, Class VI land dominates in quantity, followed by Class IV land. There are small amounts of higher-quality soil, and substantial areas of Class VII and VIII land. At a time when the new detailed survey of the flatlands is complete, the map can be revised to reflect the information, and the entire map will have a high degree of detail.

AGRICULTURE IN FREMONT

The North Plain area has 2,300 acres of land presently in agricultural uses all of which is prime land. Of the County total at 230,107 acres of agricultural land, approximately 5,500 acres are prime land. The North Plain represents 42% of the County's prime land. Total County gross receipts for agricultural products for 1972 was \$31,848,700.

It is difficult to calculate the precise value of the agricultural products produced in the North Plain. Using 1972 per acre gross income for specific crops (provided by the Alameda County Agricultural Commissioner), the following table indicates the general value of the type of agricultural products produced in the North Plain. Unfortunately, net income per acre figures were not available. H. Hall, the USDA Farm Advisor, has assured City staff that agriculture in the North Plain can be a profitable business.



FREMONT GENERAL PLAN
**CONSERVATION
ELEMENT**

**GENERALIZED
LAND CAPABILITY**

- LEGEND
- U.S. SOIL CONSERVATION SERVICE CAPABILITY CLASS
- I
 - II
 - III
 - IV
 - V (NO CAPABILITY CLASS V IN FREMONT)
 - VI
 - VII
 - VIII
 - QUARRY AREA - NO CAPABILITY CLASS GIVEN
 - CITY OF NEWARK
 - FREMONT CITY BOUNDARY



MAP 2
SOURCE: U.S. SOIL CONSERVATION SERVICE

THIS MAP IS ONE OF SEVERAL WHICH ACCOMPANY THE TEXTUAL MATERIALS OF THE CONSERVATION ELEMENT IN THE FREMONT GENERAL PLAN. IT IS INTENDED TO ILLUSTRATE THE CONCEPTS AND PROPOSALS OF THE OF THE ELEMENT, AND SHOULD BE USED FOR GENERAL PLANNING PURPOSES ONLY. PRECISE PLANNING DATA MUST BE USED TO SUPPLEMENT THIS INFORMATION AT THE TIME OF PLAN IMPLEMENTATION.

CROP	GROSS INCOME PER ACRE FOR 1972	VALUE OF CROP FOR 2,300 ACRES IN NORTH PLAIN
Cabbage	\$ 893	\$2,055,000
Cauliflower	1,144	2,643,000
Lettuce, head	800	1,840,000
Cucumbers	1,126	2,590,000
Average	992	2,282,000

If one were to look at the County devoid of urbanization, there would be 100,000 acres of prime agricultural land. Urbanization today has covered nearly 95,000 acres of this land. The last large areas of prime land in the County are in the North Plain and in the area near Sunol.

The prime land in the North Plain does have the distinction of being one of the four areas in the State (and one of the few in the United States) where the even climate tempered in the summer by fog, and in the winter by the bay, allows up to four crops a year of delicate products such as lettuce.

Soil and Land Capability Recommendations

General recommendations can be based on the land capability classification system. These recommendations involve guidelines toward use of soils as defined by classification number, and can be related to Map Two. Other recommendations using soils information are also possible.

1. Soils information — specifically, properties and interpretations — should be used as a basic data source in evaluating future City plans and development proposals. When more detailed information is available, it should be incorporated into the maps and text presented here.
2. The City should adopt the following policies about soils use:
 - a. Where practical, Class I and Class II soils should be set aside, either through agricultural preserve, open space designation, or as a City-managed land bank, for the production of agricultural crops. These lands represent a valuable natural resource which is limited in quantity, and they may well be needed for food production in the future even if not needed at the present time.
 - b. Most Class VII and VIII lands should be restricted from intensive urban-type development, due to the large array of problems and constraints inherent in them. They should be placed in an open space classification or used as pastureland or recreational land.

- c. Other lands, including Class III, IV and VI (no Class V lands have been designated in the City) soils, can generally be used for normal urban development, provided that suitable precautions are taken against the hazards (slope, erosion, soil creep, structural damage from shrink-swell) presented by specific soil types within the categories. Development proposals must be accompanied by specific solutions to any hazards involved. Examples include erosion and sediment control measures, proposed drainage systems, and other structural measures to overcome existing soil hazards.
3. Septic tanks will be permitted where public sewers are not available and the extension of public sewers is economically infeasible and septic tanks are, in the opinion of the Alameda County Health Department, permissible.
4. The City should require a geologic/soils investigation for each major development proposal, to be carried out by a qualified consultant.

These recommendations are intended to form basic City policy toward use of its land resource. Other considerations, including geologic, seismic, and slope analyses, should be used in conjunction with them. Soils information is readily available at the present time, as are competent individuals to interpret and apply it; therefore, it should be used to the extent possible. In this way, the City can better relate general planning policies and specific development proposals to those natural environmental conditions that have strong implications for urban development.

Slopes

Although information on slopes is contained in the soil surveys discussed previously, it is not highly detailed and does not reveal precisely where various slopes are located within a given area containing one soil type or association. Therefore, it is useful to further examine the nature of slopes in the hill areas of the City. This information can then be used in conjunction with a soils map to determine with more precision the physical capability of the environment to support given land uses.

Map Three illustrates slope data for the hill areas of Fremont, including Coyote Hills. Three categories are shown, each indicating a given range of slope magnitudes: 0%-14% (minimal slopes); 15%-29% (moderate slopes); and 30% and more (severe slopes).⁷

Minimal slopes are found, of course, in the flatland areas and the "foothills" of the hill area; the vast majority of the land area within the City falls into this category. Moderate slopes mark the boundary between minimal and severe slopes, and are found throughout the upland portions of the hills. Severe slopes follow the canyons and draws of the hills, and occupy over half the hill area; in some cases, severe slopes exceed 100% (45°) in magnitude. As the map indicates, severe slopes often surround small areas of less severe slopes, indicating a hilltop or valley floor.

FREMONT GENERAL PLAN CONSERVATION ELEMENT

GENERALIZED SLOPE

LEGEND

0 to 14% SLOPE

15 to 29% SLOPE

30% AND GREATER SLOPE

CITY OF NEWARK
FREMONT CITY BOUNDARY



MAP 3
SOURCE: CITY OF FREMONT

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Some of the implications of slopes for development have been discussed previously in the Soils section. Obviously, the construction of urban-type dwellings, streets, etc., on slopes requires varying amounts of grading, excavation and terracing. Where these activities take place on moderate or minimal slopes, given proper precautions against slippage, erosion, and the like, urban expansion can occur without undue damage to the environment; where slopes are more severe, grading volumes may become excessive, cuts for building pads or streets may have to be overly large, and erosion hazards may increase greatly. These conditions depend, of course, on the nature of the soil and the material underlying the soil; as the soil survey indicates, many portions of the hill areas have very thin, loose soil which simply will not support development.

The City has recognized these hazards by carefully regulating grading, especially in the hill areas, and by reserving the right to disallow it in the event of a judged hazard or danger resulting from the proposed grading activity. Many planning agencies, including the Association of Bay Area Governments, and numerous cities in the Bay Area, have recommended that building on excessive slopes be restricted or prohibited because of potential damage to the environment and because of possible safety hazards associated with living on or beneath steep slopes. As a general rule of thumb, an average slope of 25% to 35% is considered to be the maximum allowable, and anything over that should not be built upon unless it is clearly proven that no undue problems or hazards would result from the action. Much depends on the geologic makeup of the slope, and the soil type upon it.

Slope Recommendations

1. Areas with slopes of 15% or less should be available for urban development or nonurban uses (depending on their other values and characteristics) as dictated by the existing regulations and procedures of the City.
2. Areas with slopes of 15% and greater than 15% but less than 30% should be made available for limited, low-gross-density (although small, dense clusters within large sites can be allowed) development, so long as natural environmental conditions will allow such development to take place without public hazard or environmental destruction being the result.
3. Areas having slopes of 30% or more should normally not be made available for urban development of any kind.
4. Special planning procedures, such as target planning, and performance standards involving the siting and appearance of development on slopes in excess of 15%, should be developed and used prior to actual building on hill areas.

Although these recommendations are confined to consideration of slopes alone, they must be used in conjunction with previous information on the relationship of geologic conditions and soil conditions to slopes. It is clear from this body of data that the degree of slope itself is

not often the greatest problem in developing land, but that other environmental conditions coincident to steep slopes (e.g., erosion, thin soil, unconsolidated subsurface materials) actually form the heart of the problem. Slope becomes an indicator of possible hazard, and this sense can be used as one means to cope with the issue of regulating land use in environmentally sensitive area.

Seismic Hazards

Although seismic hazards do not represent a land resource, they are a condition that must be dealt with in the Fremont area. The State of California has recognized the importance of planning around seismic considerations by requiring all cities and counties in the state to develop and adopt Seismic Safety Elements within the next year. Fremont will also be required to do this work, which will involve a detailed geologic survey of the City; the importance of this survey for general planning purposes as well as for assessing seismic hazards was discussed in the section on general geologic conditions.

Because of the absence of specific information on seismic hazards in the City, the issue can be discussed here in only general terms. A certain amount of area-based information is available — much of it published by U.S.G.S. — and substantial quantities of data exist regarding the character of seismic hazards; most of this cannot be directly related to specific portions of the City. This procedure will be the central purpose of the Seismic Safety Element. In the absence of specific data, generalized information will be briefly discussed here, in order to indicate some of the possible constraints imposed on City development by seismic activity.

Some of the more defined data about seismic activity in the City concerns the approximate location of earthquake faults and fault traces. This information is presented on Map Four.

The map shows the documented location of major portions of the active Hayward Fault,⁸ which passes through the heart of the City on a northwest-southeast axis. In several places, the fault divides into two or more traces, indicating that seismic activity may occur within a zone surrounding the fault proper. Historically, the Hayward Fault has undergone movement, including surface rupture, during times of seismic activity; at present, it is undergoing creep in a right lateral direction.

The Mission Fault Tract,⁸ also shown on the map, is located in the area of the hills, and thus affects less urbanized area. It too has a history of surface cracking and movement. Although its exact location throughout the City is still a subject of inquiry, its general location is well known. Also shown in the hills is the Morrison Fault⁹ which is not as well documented.

A fourth suspected fault trace, the Silver Creek Fault Trace,¹⁰ is thought to be located about 1.5 miles west of and parallel to the Hayward Fault. This trace (shown on Map Four) is not well documented, and some question exists as to its extent and location. It is thought to pass



FREMONT GENERAL PLAN CONSERVATION ELEMENT

EARTHQUAKE FAULTS

LEGEND

① SOURCE: Map Showing Recently Active Breaks Along the Hayward Fault and the Southern Part of the Calaveras Fault Zone, California, by D.H. Radbruch, U.S.G.S. Open File Map.

— LOCATION OF A SURFACE RUPTURE FORMED DURING THE EARTHQUAKE OF OCTOBER 21, 1868.

--- APPROXIMATE LOCATION OF A SURFACE RUPTURE FORMED DURING THE EARTHQUAKE OF OCTOBER 21, 1868.

x LOCALITY OF A SURFACE CRACK.

⊗ PROBABLE LOCALITY OF A CRACK.

— OBVIOUS PHOTOGEOLOGIC OR FIELD EVIDENCE OF RECENT MOVEMENT SHOWN BY SCARLINES, TRENCHES, SAGPONDS, OFFSET STREAMS OR GOUGE ZONES.

--- LESS OBVIOUS PHOTOGEOLOGIC OR FIELD EVIDENCE OF RECENT MOVEMENT, VERY PROBABLY A FAULT BREAK.

?? QUERIED WHERE UNCERTAIN.

② SOURCE: Geology and Paleontology of the Pleasanton Area, by C.A. Hall, Jr., Univ. of Calif. Publication in Geological Sciences, Volume 34, No. 1, 1958.

— WELL DEFINED FAULT LINE

--- INDEFINITE FAULT LINE

..... CONCEALED CONTRACTS

U D INDICATES VERTICAL MOVEMENT: U-UPWARD, D-DOWNWARD.

↔ INDICATES LATERAL MOVEMENT

③ SOURCE: Geotechnical Study of the North San Jose and Alviso Area, City of San Jose, April 12, 1971.

--- BURIED FAULT IN BASEMENT ROCK. EXACT LOCATION UNCERTAIN.

— CITY OF NEWARK

--- FREMONT CITY BOUNDARY



MAP 4

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through the City's Northern Plain area near Coyote Hills, but because of few surface traces in the deep alluvium in that area, the trace is not easily pinpointed. At the present time, because that portion of the City is not urbanized to a great extent, the suspected trace affects few Fremont citizens; however, the trace may pass through the City of Newark, in which case large numbers of people could be affected.

Because the study of earthquake faults requires the input of highly trained and qualified geologists and seismologists, more precise information on the subject cannot be ventured here. It is clear, nevertheless, on the basis of documented and published information, that Fremont has its share of Bay Area seismic hazards and that efforts should be made to (1) study these further, and (2) take preliminary action toward protecting the public from potential seismic activity. The state-required Seismic Safety Element will result in a thorough study of seismic features in the City, which will provide much sounder information for City planning purposes. Until the study is carried out, efforts should be made to restrict development on or near faults or traces. Currently, the City does not permit building on a fault or trace, and this policy should be expanded to prevent building on either side of these corridors.

Along with actual fault or fault trace activity are other related conditions that could have an adverse effect on the City and its people during times of seismic activity. A clear understanding of them must await the seismic safety study, but some general comments can be made about them at the present time, if only to suggest topics for inclusion in the study.

Potential Problems and Hazards

1. **Creep:** This is the slow movement of the land surface along a fault or trace. The Hayward Fault, for example, is creeping at the present time. Creep can cause offset in roads, fences, railroad tracks, and can literally pull apart structures located over the fault. Another form of creep was discussed in the geologic and soils sections of this chapter — the creep of surface soil down a slope under certain conditions of slope angle and soil composition and moisture. Seismic shaking can vastly increase the rate of creep, and can accelerate it into landsliding, especially if the soil is moist from natural and man-induced water.
2. **Landslides:** As noted above, an earthquake can release enough energy to trigger large-scale landslides on slopes under certain conditions. Such earth movement has severe implications not only for anything located on the surface of the slide area but for anything located below, in the path of the slide.
3. **Ground shaking:** Seismic motion is a form of low-frequency wave motion which can create severe ground shaking large distances from the epicenter of the earthquake. This periodic motion is partially a function of the material beneath the surface of the earth — if bedrock, it is likely to be of a shorter period than in loosely consolidated rock or soil. Much depends on the geologic structure of the area in question.

4. **Liquefaction:** This is a phenomenon which occurs during an earthquake, in which certain types of soil will take on a near-liquid composition from subsurface water being forced upward toward the surface of the ground, as the soil is shaken down — a good comparison is quicksand. Where liquefaction has occurred, structures and other relatively heavy objects have been known to literally sink into the earth. Again, the geologic makeup of the area is the critical factor in determining whether or not liquefaction is a possibility.
5. **Surface rupture:** The most dramatic product of an earthquake is surface rupture, which is the splitting or cracking open of the earth's surface along a fault or trace. The implications for anything located in the area are obvious. It should also be noted that there is evidence to conclude that surface rupture is not always confined to a past fault or trace, but that it can occur in an entirely new location near one of these. As a result, it is necessary to denote a corridor where rupture may occur.

Seismic Hazard Recommendations

1. The City should, in the very near future, begin the process of hiring qualified consultants to assist in the preparation of a Seismic Safety Element which meets or exceeds the mandate of State law. This action should occur well in advance of the "due date" for the Element to avoid last minute work and to provide the information to City decision-makers at the earliest opportunity.
2. If soils or geologic surveys presently being required by the City (or required as recommended in the soils section) indicate evidence of faults or traces on a given parcel, development should not occur there unless it is clearly demonstrated that it will not be adversely affected by possible seismic activity. An informal policy of this type is being followed at present by the City's Chief Building Official; the policy should be formalized by Council.
3. Until such a time as faults and traces within the City are thoroughly documented, buildings for human habitation or use should not be permitted in a corridor 50 feet on either side of a documented fault or trace, or 75 feet on either side of an inferred or suspected fault or trace. After documentation through the Seismic Safety Element, these corridors can be revised to suit the recommendations of that study.
4. Where there is reasonable evidence of other seismic hazards, such as landslides, development should not be permitted until the area is thoroughly studied and it is proven that no hazard to human life will exist. The City should adopt a policy of prohibiting development in questionable areas on the basis of "reasonable doubt" about human safety, until further study provides more substantive data and allows a final decision.

These recommendations should be considered as preliminary ones which can be implemented in the absence of the Seismic Safety Element. When more specific data becomes available, they should be revised to reflect it. Although seismic hazards are not a central focus of the Conservation Element, they have been discussed here because they place severe constraints on City development and land use in certain locations; in this sense, they blend with the constraints placed on the City by other environmental considerations. As more information becomes available (e.g., the U.S.G.S.-HUD Bay Region Study program to generate detailed maps on landslide hazards), it should be used in this Element, and applied to the overall planning and development process.

FOOTNOTES:

1. Information for this section was extracted from these sources: "Generalized Geologic Map of the San Francisco Bay Region, California," U.S.G.S. Open File Map, by J. Schlocker, 1970 (BDC *); "Hayward Hill Area Study," Hayward, California, City Planning Department, April 1971, pp. 17-30.
2. This statement does not refer to seismic hazards, which are discussed in a later section; it concerns characteristics of the overall geologic structure of the City without reference to potential seismic activity.
3. "Preliminary Photo Interpretation and Damage Maps of Landslide and Other Surficial Deposits in Northeastern San Jose, Santa Clara County, California" by Tor H. Nilsen and Earl E. Brabb, 1972. San Francisco Bay Environment and Resources Planning Study, U.S.G.S.
4. "Soil Survey, Alameda Area, California," March 1966; "Report and General Soil Map, Alameda County, California," 1966.
5. "Report and General Survey Map, Alameda County, California," p. 37.
6. It is important to note that while this is true for the City, it may not be true for other areas in the region; the applicability of the system to these other areas must be carefully established prior to basing any urban planning decisions on the system used in this report.
7. The percentage of slope refers to the relative amount of vertical change of a surface for a given amount of horizontal change. A 10% slope, for example, denotes a change of 1 vertical to 10 horizontal (1 foot of rise or fall for every 10 feet of linear distance); a 50% slope denotes a change of 5 vertical to 10 horizontal, etc.
8. "Map Showing Recently Action Breaks Along the Hayward Fault Zone and the Southern Part of the Calaveras Fault Zone, California," by Dorothy H. Radbruch, U.S.G.S. Open File Map, 1971.
9. "Geology and Paleontology of the Pleasanton Area" by C. A. Hall, Jr., University of California, published in Geological Sciences, Volume 34, No. 1, 1958.
10. "Geotechnical Study of the North San Jose and Alviso Area", City of San Jose, April 12, 1971.

WATER RESOURCES

Introduction

A consideration of water resources is necessary to the Conservation Element, since water plays such a vital role in supporting both urban areas and agricultural activities. The use, conservation, supply and distribution of water become critical issues; and it is in the best interests of the public to insure that water supplies are properly managed. A second major consideration is the impact of water on the landscape; this impact manifests itself in the form of runoff, flooding, groundwater levels, surface water features and so on. Water conservation and management activities must directly relate to these matters. A third consideration is the use and/or preservation of water for recreational or esthetic activities, including the support of water-based wildlife.

As with land resources, water resource considerations can be summarized as being concerned with the effect of water and water-related conditions upon urban and rural land use within Fremont, as well as with the effects of those land uses on water conditions. The constraints imposed by water and its force on the City must be dealt with, and the impact of the City on local water supplies and use must also be considered.

General Hydrology

Fremont is located at the westernmost extremity of the Alameda Creek Basin, which is a large watershed¹ encompassing not only the Tri-Cities area, but the Livermore Valley, the cities of Livermore and Pleasanton, Del Valle Reservoir, etc. The basin, which is illustrated on Figure Two, has a land area of about 695 square miles. The larger interior portion is connected to the western portion by Alameda Creek, which flows through Niles Canyon and ultimately drains into San Francisco Bay.² The Creek itself originates on the northwesterly slope of Mount Hamilton, is fed by a number of tributaries throughout the basin and becomes the major surface water body in the area. As other chapters of this report have indicated, Alameda Creek played an important role in the formation of the Niles Cone and the alluvial plain on which Fremont rests.

All streams of the basin are intermittent, with flows depending on seasonal precipitation. In many cases, however, there is a continuous flow of water in the streambeds even though there may be none on the surface. Alameda Creek itself flows continuously, in part because of the introduction of stored and imported water supplies to it as it passes through the basin. According to the U. S. Geologic Survey, the creek (as measured near Niles) discharges an average of 119 cubic feet per second of water (86,220 acre-feet) per year over an 80-year period. In the 1970-1971 year, the creek discharged a maximum of 2,300 c.f.s. and a minimum of 9.6 c.f.s. (prior to artificial introduction of supplementary water, the creek at times did not flow at all).³ The wide divergence in flow characteristics has led to severe flooding at times in the Fremont area, giving rise to extensive flood control facility development and construction.

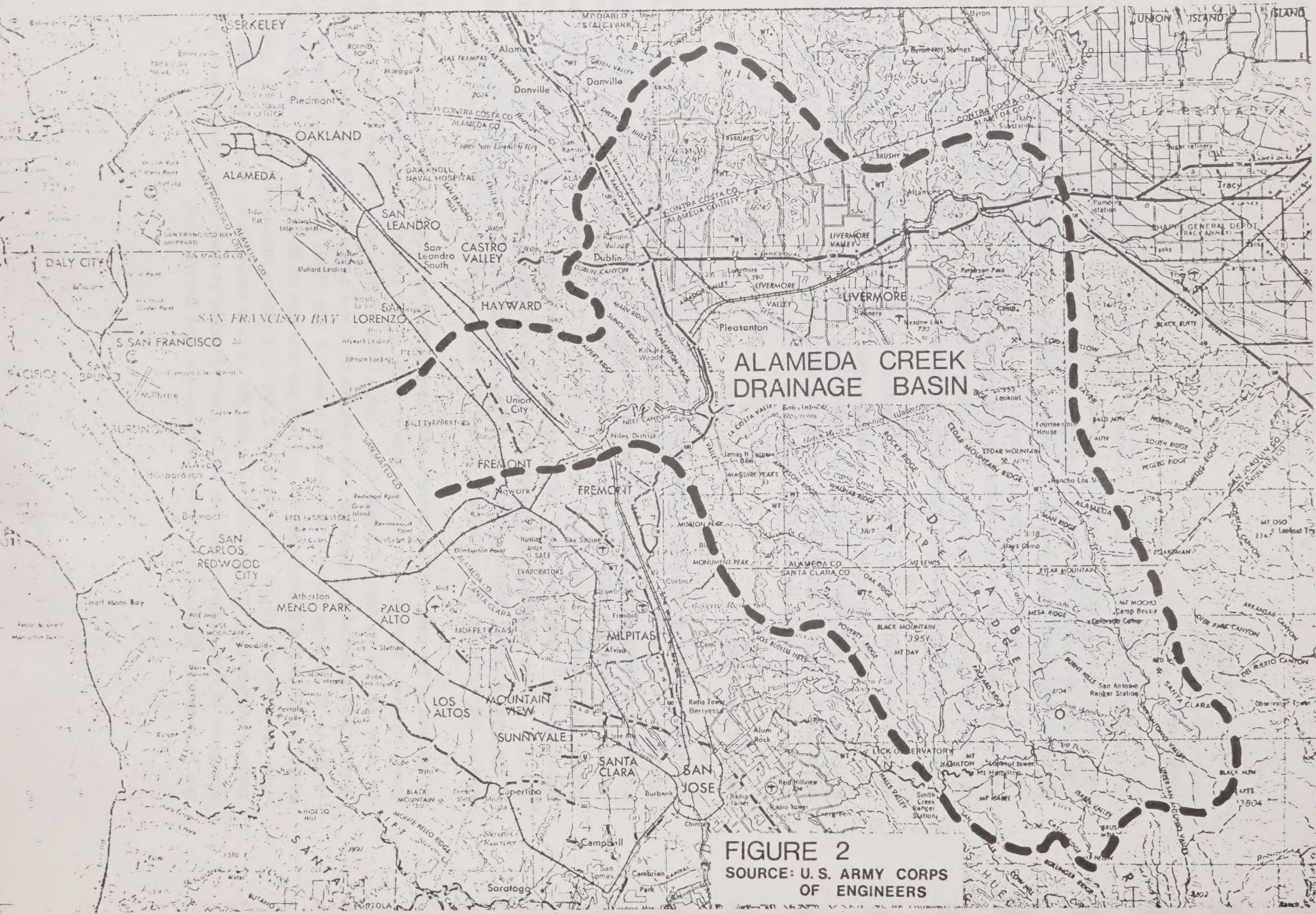


FIGURE 2
SOURCE: U. S. ARMY CORPS
OF ENGINEERS

The City's setting in this large basin is important, because activities or events affecting the nature of the water supply, drainage, quality of water and so on in the upper, or eastern, portion of the basin will have an impact on the nature of the water which reaches Fremont. For example, pollution of surface water in the Livermore Valley will result in polluted water passing through Fremont. Greater demand for water from that area will reduce Fremont's supply. In many ways, the City is tightly knit to the other parts of the watershed, and must manage its water with the balance of the area in mind. Both groundwater and surface water originate within the watershed, except for that amount introduced from outside sources (such as the State South Bay Aqueduct).

The regional perspective is one that must be retained in City decisions which relate to water supply or quality. The following sections of this report will elaborate on some of the relationships and will indicate how conditions throughout the basin can affect the City.

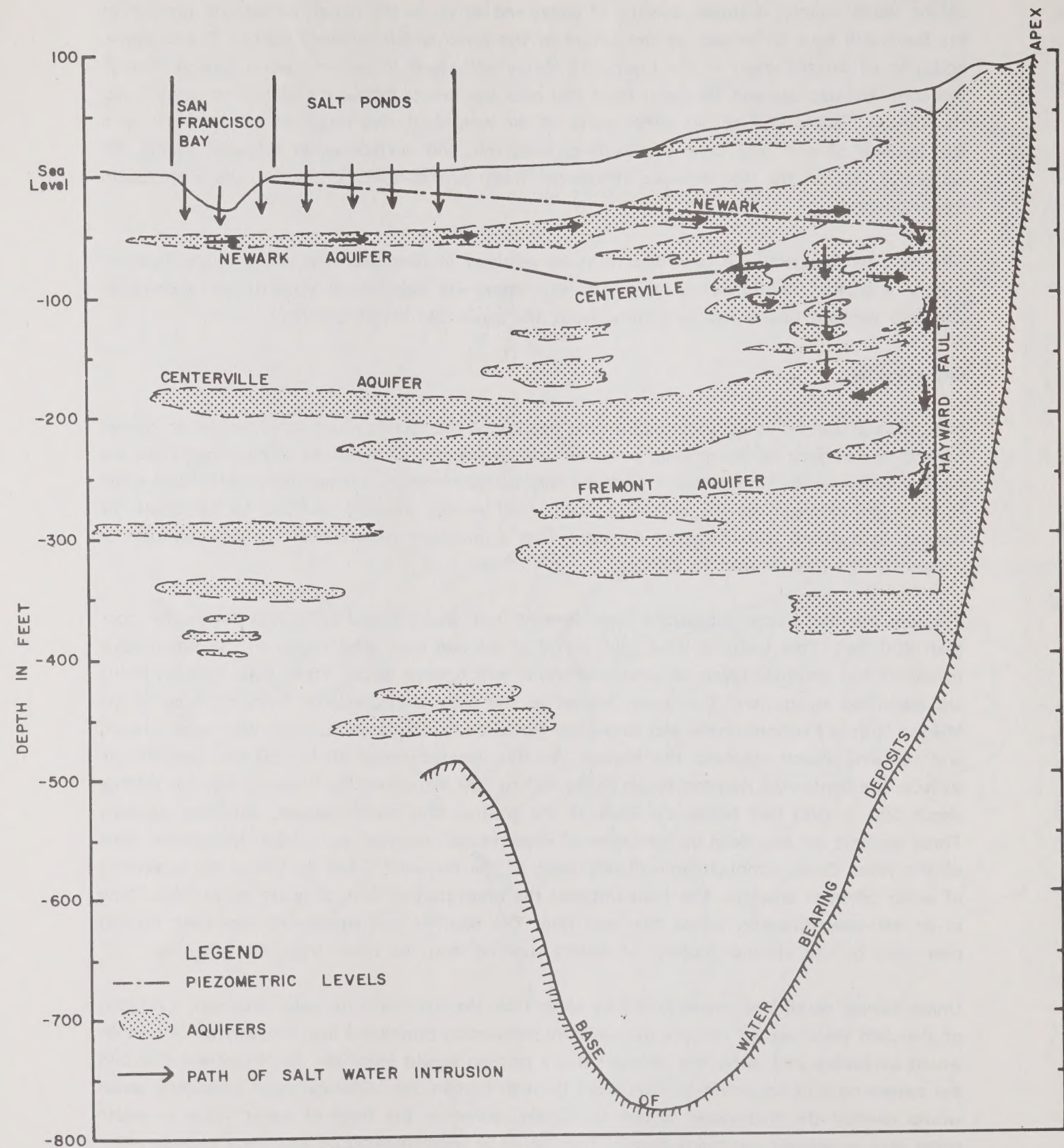
Groundwater

Groundwater can be roughly defined as that portion of the earth's water supply which is located beneath the surface of the ground. It is the principal source of water for human use, since the natural processes by which water finds its way beneath the ground generally purify and clean it; thus, groundwater can be extracted from water-bearing deposits and put to direct use for human, agricultural and industrial purposes with a minimum of treatment (unless pollution or contamination has reduced its quality).

Fremont overlies a large subsurface basin formed from bedrock and extending downward more than 800 feet. This basin is filled with layers of silt and clay, which tend to be impermeable to water, and alternate layers of sand and gravel, which store water. These water-bearing layers are identified as aquifers. The basin, known as the Niles Cone, extends from the base of the Mission Hills in Fremont on the east to the San Francisco Peninsula on the west (see Figure Three), and contains several aquifers: the Newark Aquifer, located about 40 to 150 feet beneath the surface; the Centerville Aquifer, found about 180 to 200 feet down; the Fremont Aquifer, located about 300 to 350 feet below the level of the ground; and several deeper, unnamed aquifers. These aquifers are separated by the layers of impermeable material (aquicludes) throughout most of the Niles Cone, although immediately west of the Hayward Fault there is some movement of water between aquifers. The fault impedes the underground flow of water in the Niles Cone in an east-west direction across the fault line. The aquifers and aquicludes were both formed over time by the alluvial deposits of waters washing into the basin from the hill areas.

Under normal conditions, water would be taken from the aquifers in the basin and used. A portion of the used water would re-enter the basin by percolating downward into the aquifers, a portion would evaporate and enter the atmosphere, a portion would enter the San Francisco Bay and the remaining portion would be consumed through human use (although most consumed water would re-enter the hydrologic system ultimately, either in the form of water vapor or waste water sent to sewage treatment plants). This would be supplemented by additional outside water

Cross Section: Niles Cone showing intrusion of salt water into the Fremont area



Source: Alameda County Water District

FIGURE 3

brought into the basin by rainfall on the basin itself or through surface water channels - creeks and rivers - which would carry the water into the area and allow it to percolate into the ground. Ideally, the amount of water used should not exceed the amount replaced in the basin in any given period of time.

The importance of maintaining an even balance between water usage and water supply to the basin is not only emphasized by the need to retain a reserve of potable groundwater, but is critical due to the proximity of the Bay. The Bay, being composed of salt water, cannot serve as a source of recharge for the aquifers in the Niles Cone without degrading the fresh water contained by the Cone. Thus, the water level in the cone must be such that it exceeds the water level of the Bay (sea level) in order to create a Bayward "gradient"⁴ which will hold back Bay salt water from entering the system. Were the Bay a fresh-water body, of course, its presence would be beneficial to the groundwater supply in the basin and such a gradient would be less important.

Historically, since the Fremont area was settled and groundwater was put to use for agricultural irrigation, human, animal and plant consumption, and industrial use, the water level of the aquifers in the Niles Cone was gradually drawn down to a point far below natural levels: in 1961, the groundwater level was 67 feet below sea level. As a result of this, the Cone began to be degraded by brackish, or saline, water from the Bay, which entered the Newark Aquifer, traveled along the aquifer to a point near the Hayward Fault, and then traveled downward into the Centerville and Fremont Aquifers (see Figure Three). At the present time, the Newark Aquifer is largely degraded by brackish water, and the two lower aquifers have suffered serious damage. According to the Alameda County Water District, about 1,000 acre-feet of salt water entered the groundwater basin between the Fall of 1970 and the Fall of 1971,⁵ indicating that the natural balance described above had not yet then been restored (although it had been improved, as will be noted).

Fortunately, conditions of the Hayward Fault will not permit the transfer of water from its west side to its east side and effectively insulates the portion of the Niles Cone east of it from the salt water intrusion. This source, along with outside sources, provides most of the municipal water currently being used in the Fremont area. For the foreseeable future, these sources will continue to provide most of the municipal water supplies.

The Water District has embarked on a program to restore the aquifers in the Niles Cone. The first step in this program has been to reduce the amount of water taken from the western portion of the Niles Cone and to increase the amount of water recharged to that part of the basin. Groundwater production from the western portion of the basin has declined from an estimated 21,600 acre-feet in 1971-72 to an estimated 16,200 acre-feet in 1973-74, while water produced from the eastern portion has increased from an estimated 17,600 acre-feet in 1971-72 to an estimated 18,200 acre-feet in 1973-74.⁶ Total production of the Niles Cone is also falling: in 1971-72, it is estimated at 39,200 acre-feet and in 1973-74, it is estimated at 34,400 acre-feet. Along the reduced drawdown in the basin, the District is actively recharging the basin with

imported and natural water supplies. Imported water is brought into the area from the State of California's South Bay Aqueduct (via Alameda Creek) and is added to replenishment pits located in the Niles District. It percolates downward from the channel and replenishment pits into the basin and increases the supply of water there. Map Five illustrates the location of the District's groundwater recharge areas.

Water is also imported from the Del Valle Reservoir for this purpose. San Francisco also releases water for replenishment pursuant to a water rights agreement on Calaveras Reservoir. In 1970-71, the District imported 14,300 acre-feet of supplemental water for replenishment; in 1971-72, this increased to 28,000 acre-feet; and the estimated amounts for 1972-73 and 1973-74 are 23,000 acre-feet and 23,500 acre-feet, respectively.⁷ In addition, treated water was purchased from San Francisco Water Department (Hetch-Hetchy) for direct use in the District's distribution system.

The District's program to improve the basin has resulted in a higher water table in each of the aquifers in the Niles Cone. As of Fall, 1972, the level in the uppermost Newark Aquifer was within two feet of sea level and in some areas of the City was above sea level. Lower aquifers are also being improved.⁸ However, the basin is still partly degraded with salt water, and the District is proposing a program of pumping saline groundwater that is trapped in aquifers beneath the Centerville District and Newark and discharging it into the Bay, while at the same time increasing the amount of imported water to be added to the recharging pits.⁹ Ten thousand acre-feet of imported water would be used to this end. The District hopes to, over time, recover the aquifers in the Niles Cone through this process.

In spite of the problems with the Niles Cone, the supply of water for Fremont and the adjacent cities of Newark and Union City appears to be adequate for the near future. Presently, water service to Fremont is provided by the Alameda County Water District, the Citizens Utilities Company, and private wells throughout the City which serve individual homes or industrial plants (the number of private wells is steadily decreasing). The Citizens Utilities Company serves only a small portion of the City, in the Niles area, and is currently involved in litigation connected with selling its interests to the Alameda County Water District. Since Citizens Utilities Company water is included in District calculations, the information produced by the District represents the most accurate appraisal of future water needs in the area.

The District, as noted previously, uses water from four sources: groundwater, pumping, San Francisco Water Department's pipeline, the South Bay Aqueduct and its share of water from the Del Valle Reservoir. Groundwater (after suitable treatment to remove hardness) and SFWD water is placed directly into the distribution system, and water from the remaining two sources is used at the present time to recharge the basin. The District has projected Tri-City area water demand to be about 80,000 acre-feet per year by 1995.¹⁰ the local groundwater basin will provide about 25,000 acre-feet of this, the South Bay Aqueduct will provide 42,000 acre-feet, the SFWD 10,000 acre-feet and the Del Valle Reservoir 3,000 acre-feet. This amount is intended to supply a projected population of about 390,000 in the Tri-Cities area, which is approximate



FREMONT GENERAL PLAN CONSERVATION ELEMENT

WATER RESOURCES

- AQUIFER RECHARGE AREA
- PERMANENT LAKE OR POND
- INTERMITTENT LAKE OR POND

- SALT MARSH
- INTERMITTENT STREAM
- * HOT SPRING

- FLOOD CONTROL OPEN CHANNEL
- FLOOD CONTROL CLOSED CONDUIT
- HETCH HETCHY AQUEDUCT
- SOUTH BAY AQUEDUCT

- FLOOD CONTROL DISTRICT SERVICE ZONE BOUNDARY
- SUB-WATERSHED BOUNDARY
- DIRECTION OF SURFACE WATER FLOW

- CITY OF NEWARK
- FREMONT CITY BOUNDARY



MAP 5
SOURCE: ALAMEDA COUNTY FLOOD
CONTROL AND WATER
CONSERVATION DISTRICT,
ALAMEDA COUNTY WATER
DISTRICT, CITY OF FREMONT

THIS MAP IS ONE OF SEVERAL WHICH ACCOMPANY THE
TEXTUAL MATERIALS OF THE CONSERVATION ELEMENT
IN THE FREMONT GENERAL PLAN. IT IS INTENDED TO
ILLUSTRATE THE CONCEPTS AND PROPOSALS OF THE
OF THE ELEMENT, AND SHOULD BE USED FOR GENERAL
PLANNING PURPOSES ONLY. PRECISE PLANNING DATA
MUST BE USED TO SUPPLEMENT THIS INFORMATION AT
THE TIME OF PLAN IMPLEMENTATION.

to the holding capacity population of these cities' general plans. These projections assume that the groundwater basin will be recovered by that time, that the SFWD contract (which expires in 1984) will be renewed and that the contracted amounts of water will be available from the South Bay Aqueduct. Beyond 1995, new sources of water will be needed to meet projected demands. These might include additional State Water Project water, local or regional desalinization and reclamation of waste water for specific purposes. Continued pumping by the Citizens Utilities Company (either as a separate entity or a part of the ACWD) and private concerns is included in the projected supply.

To meet increased demands, the District is proposing numerous improvements to its system, including the construction of a number of reservoirs in the eastern portion of the City and a new water treatment plant in Mission San Jose, which would treat water taken from the South Bay Aqueduct, and several new transmission mains and pipelines.¹¹ These facilities are also intended to reduce existing problems, among them a lack of the required three-day reserve of water storage capacity. Construction of the storage reservoirs and the new treatment plant is scheduled for the 1970's and construction of the water lines will occur as need arises.

In terms of service to the City, the District currently has three pressure zones of service which each relate to the elevations of the service areas. The first, Zone 1, serves all lands below 100 feet MSL. Zone 2 serves lands from 100 feet to 250 feet; Zone 3, lands from 250 feet to 390 feet. At present, service is available only in Zone 1 and in some areas of Zones 2 and 3. Service is not available to other areas in Zones 2 and 3 and higher zones unless applicants assume full costs of all storage, treatment and transmission facilities as well as paying for the water delivered to them.¹²

The foregoing has been a very brief summary of several complex subjects: groundwater hydraulics, aquifer degradation and reclamation actions, water demand and supply, and service areas. The Alameda County Water District or other agencies noted in this chapter should be contacted for more detailed information on these matters. It has been the purpose of this section to highlight the groundwater system and supply for the Fremont area, and to lay the framework for a discussion of the planning implications and concerns related to the subject matter.

Foremost in these concerns is the continued improvement of the Niles Cone groundwater basin. Should the reclamation effort fail, the Tri-Cities area would possibly face a shortage of dependable water supply unless the anticipated 15,000 acre-feet needs from it by 1995 is obtained from other sources. Accordingly, it seems very important that the ACWD program to halt salt water intrusion and drive it from the basin be continued. This program, of course, is not without its side effects: for example, recently there has been expressed concern in the form of City staff reports on development proposals in the Northern Plain area about the level of the subsurface water table, which, it is maintained, is very close to the surface of the land. Obviously, a situation of this type has severe implications for certain uses of the land — notably urban uses — especially at low surface elevations (the western portions of the Northern Plain are below 10 feet MSL).

It is not known for sure whether the Newark Aquifer is supplying this water, or if the water is the product of small, isolated, "perched" aquifers; in any case, the matter needs a complete exploration prior to additional development in the area. It is possible that the water levels would rise in the future due to natural recharge, even if the District failed to recover the basin, in which case demands on the basin would be less than recharge; water level problems could occur in the absence of District programs. Even if it is demonstrated that the basin recharge program is responsible for the rising water level there, the program should take precedence over potential urban use of that land. A similar issue involving water levels in the Niles Quarry was litigated in recent years and it was determined that the program of the District should proceed.

Assuming full reclamation of the basin, Water District projections indicate that the anticipated supply of water will be exceeded by demand resulting from population growth by the 21st Century. This projection also embodies certain assumptions about the availability of water from outside sources — which would be providing most of the water uses by that time. In the event that these supplies are not available when needed (for example, if the SFWD could not provide the forecast annual 10,000 acre-feet), other local or regional sources of water will have to be found. District officials have expressed confidence that these sources will be available, especially if new programs such as waste water reclamation are instituted. Still, there is cause for consideration of not only increased demands brought about by population growth, but increased per-capita public consumption and industrial consumption. The supply of water, both local or regional, is finite, and pressures to reallocate Fremont's share may grow as urban development occurs in other portions of Northern California and the Bay Area. At the least, the market price of water may rise substantially as it becomes more scarce, resulting in increased costs to landowners and businessmen, as well as to public agencies managing water for public use. The Water District is obligated by law and policy to provide water services to customers, under reasonable conditions, so long as the supply for the District as a whole is not endangered; the District cannot take steps to slow demand which may appear to be unreasonable by present standards. Therefore, it is incumbent upon the general-purpose municipal governments in the Tri-Cities area, which can control demand through managing and guiding growth, to consider this matter, communicate with Water District officials, and develop long-range policy regarding future population growth and subsequent water demand.

Another important planning implication of the groundwater supply and the District's management of it relates to the hill areas. As was noted, the District has formally decreed that development in the hill areas should bear the full direct cost of supplying water service: in economic terms, hill area residents will pay the full marginal cost of water service to them, and other service area residents will not be required to subsidize them (as they would if hill area residents paid only the average cost of water supply). Since nearly all water in Fremont must be obtained from the District, there is little chance of individual developers drilling their own wells (geologic conditions prohibit this in the hill area) to supply large tracts. The result of the District's hillside development pricing policy will be large cost increments to developers, which will be passed on to buyers of homes in the hills. Other implications relate to density of hill area development: to economically sponsor water supply systems, developers may have to subdivide large tracts with

many dwelling units in proximity to one another, which in turn may adversely affect (or be affected by) natural environmental conditions in the hills. The issue is an open one at the present time, but the need to fully explore and resolve it will grow as pressures increase for hill area development.

Related to but distinct from the above is the matter of environmental impact of water supply facilities in the City. In the past, the District has been able to construct necessary facilities and plants without lengthy analysis of environmental effects. The advent of NEPA, CEQA and Friends of Mammoth has changed this situation, and the District must now carefully consider the effects its proposals have on the natural environment. A particular point of issue is likely to be the hills, since large-scale development of supply or storage facilities (regardless of who pays for them) may well have a significant adverse impact and possibly could be disallowed. There is no way to predict this at the present time, but it is a consideration that must be kept in mind when developing planning proposals (either for homesites or for water systems to serve them) in those sensitive environmental areas.

There are numerous other inter-relationships between development plans in Fremont and water service and supply. For example, development of land into any type of urban use will vastly increase the runoff quotient of rainwater or any other surface water. Runoff will have to be channeled into flood control facilities to avoid flooding or ponding problems. These facilities do not normally allow for much percolation of water into the underground basin, which in turn reduces the recharge of the basin and could subsequently result in a small reduction in total basin water supply. The District, in its 1973 Survey, noted that adjustments to the alignment of Alameda Creek could affect recharge to an unknown extent; similar concern could be expressed about other flood control improvements which improve drainage but slow recharge.

Groundwater Recommendations

The list of concerns could go on, as the linkages between urban development, land use and water conservation are many and complex. Because the Conservation Element alone cannot resolve these issues, it is necessary that procedures be established to allow an exploration, at length, of these kinds of questions by the Water District and the City.

1. The City of Fremont and the Alameda County Water District should jointly establish a permanent Planning Coordinating Committee to consider issues of long-range significance in the conservation of, demand for, and supply of water as it relates to the planning program of the City. This Committee should meet on a regular basis with the intent of exploring these issues of common concern which have long-term implications for residents of the City and customers of the District.
2. The City should support the efforts of the District to reclaim the Niles Cone groundwater basin.
3. The City should fully explore the potential fiscal impacts of a more costly water supply

to future residents, particularly in the hill areas, and determine the impact of this on the General Plan for those areas.

4. The impact of maintaining a Bayward gradient in the Niles Cone upon the shallow groundwater level in low-elevation portions of the City should be determined at the earliest opportunity through the studies of qualified geologic and soil experts; if it is concluded that these areas will be rendered undevelopable by rising water levels, they should be redesignated on the General Plan from an urban to a non-urban land use.
5. The overall effects of continued population growth in the State, region and City must be studied by the City and District together (perhaps using the Planning Coordinating Committee recommended above), the linkages established and identified, and recommendations made toward adjusting future plans to be in accord with water supplies.

These are generalized recommendations and do not specifically relate to mapped data. Rather, they are intended to propose the development of means to further explore common, complex problems and issues confronting both the Water District and the City. The relationship between vital utility services and urban expansion is well-documented; what must be done is to clearly define that relationship in the Fremont area. In this way, both short-range and long-range conservation and protection of the groundwater supply will be achieved.

Surface Water

Surface water is that which is located at or above the surface of the ground. It includes oceans, lakes, ponds, rivers and streams, and all other bodies of water which occur at ground level or above. Surface water is generally not used as a direct source of water supply for human consumption (although in the case of canals or open aqueducts, this is not always true) but is extensively used for esthetic and recreational purposes. It is a necessary and important component of the overall hydrologic system, since surface water provides habitat for much of the world's plant and animal life.

The source of surface water is atmospheric precipitation in the form of rain or snow (although in some cases groundwater will flow into surface water bodies and replenish them). As precipitation occurs, water is deposited on the land and begins to flow into basins or channels within watersheds, seeking the lowest point accessible to it. In the Fremont area, this point is the San Francisco Bay, which is near sea level. In the event of land areas which are below sea level, water will collect in these areas rather than flow into the Bay, forming natural ponds; this can also occur on lands above sea level if there is no lower route to allow passage downward. As the water moves and collects, it tends to carve its own paths through the land, creating riverbeds, gorges, etc. It also generally carries materials with it — soil, for example — which is then deposited at some point downstream where the flow slows enough to allow a settling out of these materials in the form of silt. The power and force of surface water acting on the landscape over long periods of time is tremendous and is visible in the form of massive channels, such as the Grand Canyon and Yosemite Valley, both of which were formed in part by flowing surface water.

The hydraulics of surface water are complex, and cannot be fully discussed here. However, there are some important factors that should be identified. One of these is the impact of a relatively small amount of rainfall on surface water levels within a watershed. One inch of rain which has fallen on one acre of land (not accounting for evaporation or absorption by the soil) will result in about 27,154 gallons of water, which will become part of the surface water flow. Realistically, of course, some of this will be absorbed into the land, and a portion will evaporate, but substantial amounts will remain. A drainage basin containing many square miles of land will, therefore, upon experiencing modest amount of rainfall, produce vast quantities of surface water.

The impact of soil absorption, or permeability, on groundwater is considerable. A highly absorptive soil, such as some of those discussed in the Land Resources chapter, will vastly reduce the amount of precipitation that actually reaches surface water bodies and channels. Other types of soil have lower permeability properties which increases runoff. The addition of manmade works to the landscape (such as homes, streets, parking areas, etc.) can vastly reduce permeability and increase runoff. The Alameda County Flood Control and Water Conservation District estimates that the following improvements to land have runoff coefficients (the percentage of water that runs off, rather than drains into, average soils surfaces for a given area) as noted below:

- Standard residential development: coefficient of .4 (40% runoff)
- Planned unit development: coefficient of .5 to .8
- Industrial development: coefficient of .5 to .6
- Commercial development: coefficient of .6 to .7
- Business development: coefficient of .6 to .8
- Paved areas (streets, parking lots): coefficient of .95

Where the surface water is generated is also a matter of concern. Large amounts of runoff at the head of the watershed will increase in velocity and volume as they move downstream (given no devices to slow or spread flow) and can easily overload downstream drainage systems. Straight, lined channels will pass flows of water much more quickly than will naturally meandering rivers and streams, and will contribute to downstream volumes of water. Exposed soil will move with the water if velocity is maintained, then will be deposited at a point where the water is slowed too much to carry the material; in some cases, channels will be clogged by silt. On the other hand, silt is often very fertile soil and creates exceedingly productive agricultural lands, as is the case in many floodplain areas. (It should be noted that the alluvial plain on which Fremont is located was formed by this type of erosive action over thousands of years, as silt and other materials washed down from the Diablo Range onto the Bay Plain.)

The quality of surface water is important, although water quality does not normally affect its ability to move about. High-quality water is valuable to serve as a replenishment supply for underground basins. Clean, unpolluted and uncontaminated surface water is also necessary for the existence of aquatic plant and animal life, and for human contact such as swimming. Much has been documented in recent years about water pollution problems in the Bay Area, and agencies presently exist which have the mission of improving water quality and insuring that it is maintained.

Fremont is located almost entirely within Flood Control Zones 5 and 6. These zones represent the watersheds of the various streams which flow through them. The zones are divided by a drainage divide which extends from the Bay roughly along or parallel to Stevenson Boulevard to the north ridge of Morrison Canyon. Streams in the northerly watershed (Zone 5) include Alameda Creek, Crandall Creek and Coyote Hills, Newark, Plummer and Mowry Sloughs. Streams in the southerly watershed (Zone 6) include Mission Creek, Agua Caliente Creek, Agua Fria, Toroges Creek, Scott Creek, Mud Slough and Coyote River. These and many of the smaller streams and Flood Control facilities are shown on Map 5. Many of the smaller creeks are intermittent, flowing only during the rainy season, and dry the rest of the time; Alameda Creek through Niles Canyon flows continuously. Some of these streams and other facilities deserve a brief separate discussion.

Alameda Creek is the largest body of flowing fresh water in the City. Originally, the creek left Niles Canyon and meandered across the northern part of the City. On occasion it overflowed its banks and spread out over the flood plain, depositing water and silt and causing substantial damage to property in the area. In 1965, the Army Corps of Engineers carried out a project to straighten, deepen and line the creek and thus eliminate the flood hazard. This project was successful in that no further floods of consequence have occurred from the creek. The channel is designed to handle water produced by the "Standard Project Flood" (a Corps design criteria), or about 52,000 cubic feet of water per second. It carries widely fluctuating volumes of water depending on the season; most of the time it flows far below capacity. It is used in part by the Water District as a groundwater recharge facility and recreational trails have been developed along a portion of it; further recreational use is proposed on the City's General Plan.

Lake Elizabeth and the Swim Lagoon are located in the City's Central Park and serve the dual purpose of providing recreational benefits while serving as ponding facilities for flood control purposes; the lake is proposed to cover a larger area than it does now, but even without further expansion it has a high recreational utility to residents of the City. It also provides valuable wildlife habitat in its backwater and marshy areas.

The Coyote River and several large sloughs connect the western portion of the City with San Francisco Bay. Since the establishment of the National Wildlife Refuge's Fremont Unit, these areas are protected from adverse urban influences and serve as habitat for a large variety of flora and fauna (see Ecological Resources chapter). These watercourses also serve to expel surface water from the City into the Bay. Because they are now protected by both the refuge and by the Bay Conservation and Development Commission, there is little chance of serious damage being done to them, but the City should continue to support their preservation as passive recreational areas and important wildlife habitat.

The Niles Quarry is a series of sand and gravel pits which are still being used; upon ceasing operations, the quarry operators are required to rehabilitate the sites. The City's General Plan indicates that the quarries are to become an aquatic park upon rehabilitation. These pits, along

with the Water District's recharge pits nearby, will serve a valuable function in sustaining the groundwater supply while providing recreational facilities to regional inhabitants.

The small, intermittent streams in the hills — Mill Creek, Scott Creek, etc. — provide much-needed water supplies to adjacent plant life and serve as valuable relief to the relatively dry hillsides around them. Most of the watercourses are lined with thick vegetation which tends to stabilize the soils and slow erosive effects of the water. Many of these streams have high scenic value. Although they become dry on the surface during the summer, water tends to remain in the earth below the streambeds and continues to supply moisture to plant and animal communities. Because the streams meander down the hills, following canyons and draws, they serve as valuable water-retaining mechanisms, retarding runoff and providing sites for subsoil permeation. The nature and function of these streams should not be hampered with in the future, and there is great potential for the use of some of them for open space and recreational sites.

The Bay, of course, is the largest and most prominent water landmark in the City. Its problems of fill, pollution and contamination are well known, as are the efforts of BCDC, the regional water pollution control agency, and the local governments along the shore to abate existing problems and prevent new ones from occurring. In Fremont, the shore of the Bay forms the western perimeter of the local unit of the National Wildlife Refuge, a facility which should insure that no further adverse actions occur within the City that would damage the Bay or its associated marshlands. Of prime importance in insuring the integrity of the Wildlife Refuge and marshland habitat is the protection of that environment from pollutants which can be transferred by ground water from anywhere in the large drainage basins which drain into the Bay.

Large portions of the tidal flats of the Bay have been diked into salt evaporation ponds - Fremont's salt industry is among the largest in the State - which reduce the area available for natural plant and animal life to inhabit. The City should promote conversion of salt ponds to salt marsh and tidal flats if the salt producers cease or cut back operations; development of those lands not in the wildlife refuge should be strictly limited in the interests of promoting a regional resource that has already been recognized by the State and Federal Governments. The marsh and sloughs form a complex and delicate marine ecological system which has an enhanced value by virtue of its being located in a highly urbanized area.

Because of the flood hazard in the City and surrounding areas, the Flood Control District has developed a complex series of flood control channels, conduits and ponding areas. These are also shown on Map 5. According to the District the system is not designed to handle a 100-year flood. Minor in-tract facilities which drain an area less than 50 acres are designed to handle a 10-year storm and facilities which drain larger areas are designed to handle a 15-year storm. All flood control facilities in these zones are designed to handle the 15-year storm, with freeboard, except Alameda Creek Federal Project which, as was previously mentioned, is designed to the Army Corps of Engineers' Standard Project Flood. While the system is designed to handle increased runoff from urbanization on the flatlands, development in the hill areas may well overload lower (downstream) segments of various lines. The District has proposed a number of additional

improvements throughout the City, including some work in the hill areas which would involve maintaining the integrity of the natural watercourses through removing debris from the channels. This is important because artificial channelization of the hill area streams would simply increase the velocity of water and would further overload downstream facilities. Because of the high degree of urbanization on the flatlands, the District's program involves artificial drainage ways there, which do not appear to create adverse impacts on the quality of the urban environment.

Other impending improvements to the flood control system include the proposed improvement of the Alameda Creek flood control channel from Coyote Hills to the Bay, along the alignment of Coyote Slough. The proposal, made by the Army Corps of Engineers, would involve the dredging and widening of the Slough to serve as the final link in the area's flood drainage system. About 250 acres of salt pond would be converted to flood control channel and salt marsh uses.

Integral to flood control is the use of ponding areas. These lands are set aside as temporary ponding facilities, to allow the short-term storage of water following a heavy rain. As the runoff subsides, the ponds are emptied into the system and the land can again be used as it was before the formation of the ponds. Because of the nature of these land areas, they cannot be used for intensive land uses and should be reserved as open space or agricultural areas, as most of them are in the City at the present time. Map Five indicates the location and approximate size of these ponding areas.

As with groundwater, a number of concerns and implications about surface water in the Fremont area can be identified. These matters are based on both existing conditions and anticipated future ones, given existing General Plan designations.

The first area of concern is the ability of the flood control system to effectively serve all potential development in the City. According to officials of the Flood Control District, the drainage systems are designed to serve forecast development on the flatlands, given no increase in the runoff coefficients cited earlier. If the coefficients increase, either through recomputation of runoff factors or through changes in the development pattern, the present system could be overloaded. For example, substitution of high-density residential development for lower-density single-family detached housing is likely to increase the coefficient from .4 to as much as .8, a 100% increase in surface water runoff which will have to be absorbed by the system. The District, in order to pre-empt as many of these problems as it can, coordinates development with its constituent cities, including Fremont, on a case-by-case basis. This activity helps avoid the more immediate problems but is not the most optimum way to achieve sound, coordinated planning.

One example of the deficiency concerns the hill areas. Although the City's General Plan forecasts substantial development in the hills, it is not certain whether or not the runoff generated by such development could be absorbed by the flood control system without major improvements. Flood Control District officials have indicated their concern about this problem, which is an especially critical one due to the fact that increased runoff at the top of the drainage system will result in massive overloading further downstream, with resultant ponding and possible floods

occurring during the rainy season. Because the hills are, in many places, steep and relatively impermeable to rainwater, runoff from them already constitutes a problem that must be dealt with in the flatlands below. The development of streets, homesites, parking areas, etc., on the hilltops would aggravate the situation unless the loss of natural surface water control were compensated for by more substantial drainage facilities. In addition, development of portions of the hills could result in the destruction of watercourses, which would increase the load on the artificial system.

A second, and related, problem is the clogging of downstream drainage channels by silt. Any removal of plant cover, grading or similar activity is bound to result in certain amounts of wind and water erosion, particularly during periods of rain. Material carried by wind or water will eventually find its way into the system and will fill channels, ponding areas, etc., with sediment which must be removed artificially if the system is to continue functioning.

A third potential problem resulting from urban development is the loss of natural groundwater recharge area. This was mentioned in the groundwater section and also applies to surface water. The same situation can adversely affect both groundwater and surface water conditions, since the two are so closely related.

These three problems all relate to the impact of the General Plan upon the natural environment. As with groundwater related concerns, there is a potential problem regarding the long-range coordinative actions of the surface water management agency (Flood Control District) and the City: little evidence exists that the District and the City have jointly explored the long-term implications of their actions (although a specialized City Flood Control Advisory Committee provides data to City officials on flood control projects). As was noted previously, District officials have expressed concern about the runoff implications of development which could have adverse effects on the overall drainage system. The District is required by law to provide whatever flood control protection it can, but must receive long-range cooperation from the City (and other cities in the county) in management of City development to pre-empt most serious problems of flood control. It would seem incumbent on both the City and the District to explore in unison the precise implications of anticipated urbanization over the next 20+ years. The impact of urbanization on surface water must be explored, along with more specific questions having to do with flood control, continued protection of natural watercourses, etc.

A major area of concern is that of public access to various surface water bodies. At the present time, the Alameda Creek channel is flanked by trails which provide significant recreational opportunities to residents of the Tri-Cities. There is limited public access to the Bay, however, since most of the land is either in private ownership for salt production or is a part of the wildlife refuge, which has not yet been improved for public access. City plans have been prepared for an aquatic park in the Niles Quarries and in the ponding area near Coyote Hills. Lake Elizabeth and the Swim Lagoon are, of course, open to unlimited public use. There are, however, numerous other areas containing bodies of water — in particular, the streams in the hills — which are not readily accessible to the public. Most of these streams are on private land and are out of reach

of the public. Segments of the flood control system in the flatlands are not made available to public use, although the City has reflected greater use in its General Plan.

There are two reasons for the limited public access. The first is the reluctance of the Flood Control District and other public agencies concerned with flood prevention to allow open access to facilities because of legal liabilities in case of accident or injury. The District, for example, allows public access only when another agency expressly assumes liability. The second reason concerns the appropriateness of public access to certain natural areas which are associated with water — either streams or Bay-related — in view of the real possibility of misuse of these areas. This is especially critical in regard to the wildlife refuge.

Questions of public access for recreational purposes to various bodies of surface water should be resolved in the future. As development proceeds, reservation of public lands will accompany it in accordance with local regulations; these lands should, where possible, be associated with surface water. The City should be prepared to assume liability for making additional flood control facilities available for public recreation, as it already has done in some instances. There will very likely be a need, however, for discretion in releasing these areas to the public, to allow for protection of the more environmentally sensitive areas.

Another major area of concern is one which was briefly discussed in the groundwater section. It involves the impact of surface or subsurface water upon land use, such as the potential drainage problems due to rising water table in the Northern Plain area and the limitations imposed by temporary ponding of excess surface water during periods of high runoff. Map Five shows the ponding areas; more study is needed to determine the extent of ground/surface water problems in the Northern Plain. In either case, development should not proceed in any questionable area until such questions are completely resolved. Ponding areas need to be preserved from development pressures, and lands having suspected drainage problems should be set aside from immediate development until it is determined whether or not they can support it. Further, some form of protection must be extended to surface water bodies which may in later years be damaged by nearby urban-type land uses — special concern should be given streams in the hill areas, since most of the Bay lands already are restricted from urbanization.

An additional problem area exists about which little precise information is available. That is, the effect of high tides and surface water on lands below the 10' contour (lands between mean sea level and 10' above mean sea level). In the event of high tide and excessive rain, tidal action could reach somewhere between 7-9 feet above mean sea level according to the Flood Control District. The Baylands, however, are served by an extensive series of levees, which help to avoid this situation. But, an extensive earthquake might jeopardize the control efforts of the dike system. The Seismic/Safety Element should study further the relation between earthquake damage and surface water control. A 100 year flood, combined with either high tide and/or earthquake damage to levees, could result in flood water damage to areas below the 10' contour.

The introduction of residential uses into areas below the 10' contour is more serious than some other land classification, due to the higher population concentration. For instance, certain industrial

uses are more flexible as to the type of structure required. Low intensity industrial uses may be feasible in areas below the 10' contour, where residential development is much more questionable. Any Environmental Impact Report on uses below the 10' contour should take these things into consideration.

Surface Water Recommendations

All of these concerns have obvious implications for future City planning and development. Some of them can and should be resolved in the near future — if only to pre-empt more serious problems later on — and others will require ongoing study through the normal planning process.

1. The City of Fremont and the Alameda County Flood Control and Water Conservation District should jointly establish a permanent Planning Coordinating Committee similar in structure and purposes to the committee recommended in connection with the Water District. The Committee should serve as the principal vehicle for discussion and resolution of long-range matters of common interest. It should contain both technical staff and policymakers and should be able to influence the direction of both the City, in its planning efforts, and the Flood Control District, in its system improvements and planning proposals.
2. The problems of hill area development, with special reference to system overloading and water erosion, must be completely studied prior to any development occurring in the hills. The utility of natural watercourses as unimproved drainage facilities must be considered and efforts made to preserve streams in their present state for both drainage and recreational purposes.
3. Where surface water bodies play a role in groundwater recharge, they should be protected from modification or reduction in size and function.
4. Public use for recreational activities of surface water bodies not presently so used should be studied in conjunction with the City's recreational program. A clear definition of water related recreational needs should be made, and appropriate water bodies set aside and managed for recreational use. The adverse impact of public use upon surface water must also be considered in this process.
5. Federal programs to preserve and improve the new wildlife refuge along the Bay should receive total City support and assistance.
6. Where possible, natural flood control conditions (streams, open and permeable land, water-storing vegetation, etc.) should take precedence over artificial facilities.
7. The Flood Control District should, along with the City, embark on a comprehensive study of hydraulic conditions in the Fremont area, to gain a better understanding of the relationships between urbanization and surface water conditions.

These recommendations are quite generalized and most relate to further needed actions. While the areas indicated on Map Six should be protected from adverse influences, many issues related to surface water cannot be mapped at the present time and therefore, will need more analysis before specific land-related recommendations can be made.

Water Quality

In connection with discussions of surface water and ground water, it is useful to briefly explore the matter of water quality. Quality is, of course, an important consideration, since it determines whether or not sources of water can be used for human consumption, and poor water quality generally indicates some form of contamination or pollution which should be abated.

As noted in the section on groundwater, one of the principal problems in Fremont is the degrading of the Niles Cone with brackish water. Salt water is not precisely a pollutant or contaminant, since by itself it presents no insidious threat to human health; rather, it simply renders the water supply unpalatable for use. In some ways, then, the problem is more easily dealt with than are other types of pollution problems, but is no less serious in its implications for the municipal water supply. The Water District is taking steps to drive the salt water from the aquifers in the Niles Cone, but the ultimate success of this effort cannot be determined at this time.

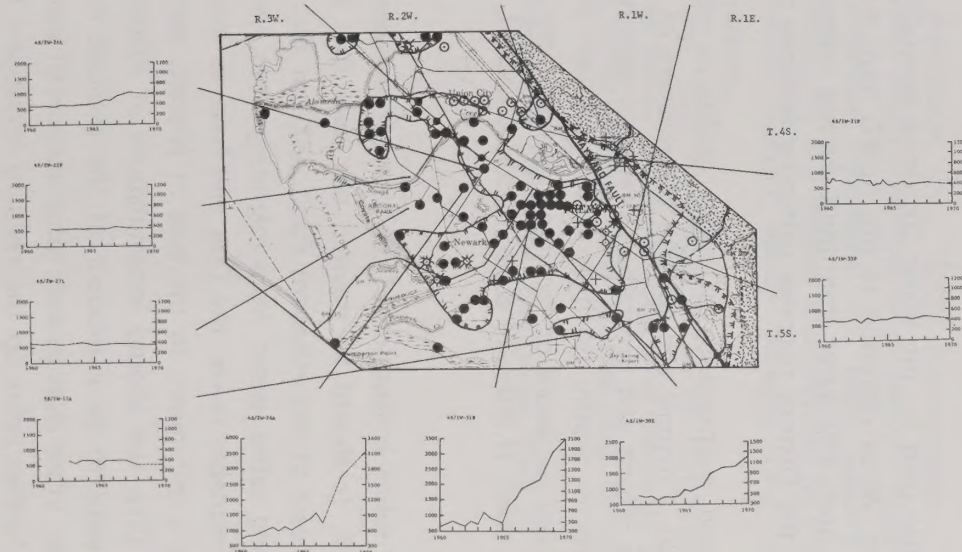
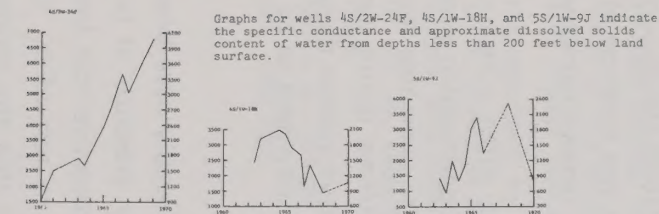
Salt water intrusion has also been investigated by the U. S. Geologic Survey¹⁴ in a study carried out within the Bay Region. The agency has identified numerous areas within Fremont and the surrounding area where dissolved solids (dissolved salts in solution) reach or exceed recommended standards, rendering the groundwater unpalatable to humans, unsuitable for certain industrial processes and hazardous to agriculture. Figure Four shows the locations of these sites, each of which exceeds the maximum standard of 2,000 mg./liter (500 mg./liter is considered by the U. S. Government to be a practical maximum). These data confirm the problems identified by the Water District and add weight to proposals to abate the problem.

The U.S.G.S., in its study, also investigated concentrations of Nitrate and Boron in groundwater through the Bay Region. Where Nitrate concentrations exceed 45 mg./liter, the water may be injurious to infants and harmful to certain industrial processes; and where Boron concentration exceeds 1.0 mg./liter, water may be injurious to trees, plants and crops. Figure Four shows areas within the City and nearby area where these concentrations are met or exceeded. It is worthwhile to note that while dissolved solids are generally confined to areas west of the Hayward Fault, Boron and Nitrate concentrations cross the fault. Both chemicals occur naturally in water, rocks and soils, and both play a role in plant and animal life cycles; but excessive concentrations create problems. Additional sources of Nitrate include decomposing wastes from canneries, septic tanks and cesspools and sewage treatment plants. Boron often comes from areas underlain by marine sedimentary rocks and fractured igneous rocks; water in volcanic areas and the water of thermal springs may also contain high concentrations.¹⁵

EXCERPT FROM

MAPS SHOWING AREAS IN THE SAN FRANCISCO BAY REGION WHERE NITRATE, BORON, AND DISSOLVED SOLIDS IN GROUND WATER MAY INFLUENCE LOCAL OR REGIONAL DEVELOPMENT

Mapped, edited, and published by the Geological Survey
Data from a special study financed in part by the
Department of Housing and Urban Development



Graphs for wells 4S/2W-24L, 22F, 27L, and 5S/1W-17A indicate the specific conductance and approximate dissolved solids content of water from depths greater than 200 feet below land surface.

Graphs for wells 4S/1W-30E, 31B, and 4S/2W-26A, perforated at depths greater than 200 feet below land surface, show changes in specific conductance and approximate dissolved solids content of water from a heavily pumped area that is being contaminated by poor quality water (4S/2W-24F) from the upper part of the aquifer system.

WELL LOCATIONS

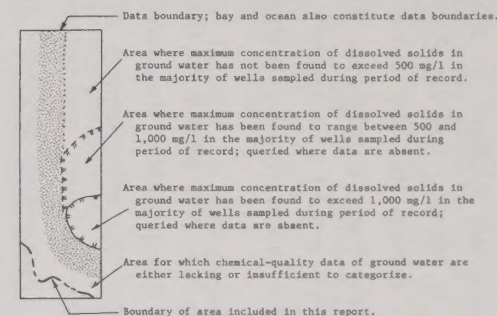
Well locations are indicated by symbols that follow the rectangular grid system of the public-land surveys. The first symbol designates the township north or south of the Mt. Diablo Base Line; the second symbol, the range east or west of the Mt. Diablo Meridian; the third symbol, the section within that township; and the fourth symbol, the subdivision of the section by 40-acre tracts, as shown in the diagram. Thus, well 9N/8W-7Q, for example, is located in Township 9N., Range 8W., section 7, SW¹/₄SE¹/₄.

D	C	B	A
E	F	G	H
M	L	K	J
N	P	Q	R

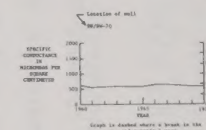
MAP EXPLANATION

SYMBOLS

- Location where nitrate concentration in ground water has exceeded 45 mg/l; water may be injurious to infants and harmful to certain industrial processes.
- +
- Location where boron concentration in ground water has exceeded 1.0 mg/l; water may be injurious to trees, plants, and crops.
- Location where dissolved solids concentration in ground water has exceeded 2,000 mg/l; water may be unsuitable to humans, unsuitable for certain industrial processes, and hazardous to agriculture.
- ◆ Location where boron and nitrate concentrations in ground water have exceeded 1.0 mg/l and 45 mg/l, respectively.
- ◆ Location where nitrate and dissolved solids concentrations in ground water have exceeded 45 mg/l and 2,000 mg/l, respectively.
- ✱ Location where boron and dissolved solids concentrations in ground water have exceeded 1.0 mg/l and 2,000 mg/l, respectively.
- ✱ Location where boron, nitrate, and dissolved solids concentrations in ground water have exceeded 1.0 mg/l, 45 mg/l, and 2,000 mg/l respectively.



GRAPHS



BY
D. A. WEBSTER
1972

The quality of surface water in the Fremont area, and throughout the Alameda Creek watershed, is fairly good. According to regional and Federal agencies, including U.S.G.S., there are some surface water pollution problems in Alameda Creek and other streams which stem from municipal and industrial waste disposal systems in the Livermore Valley and other upstream portions of the watershed. Waste is transported via Alameda Creek into the Fremont area, and reaches its peak in concentration during the dry autumn months when natural flows are at their lowest. In order to better assess these conditions, the U.S.G.S. is proposing a basin-wide water quality monitoring system which would conclusively pinpoint the sources of real and potential pollution and would allow better water quality management.

Current records of U.S.G.S. also deal with the problem of suspended sediments in Alameda Creek. These materials, which are generally fragments of rock, soil, silt, etc., reduce the quality of surface water as well as reduce the effectiveness of the drainage system. Large amounts of sediment implies erosion problems upstream, and suggest that better soil management practices be employed throughout the basin. Suspended sediment in the creek as measured near Niles varies; in 1969 and 1970, the amount of sediment ranged from 47,200 tons per day (in January, 1970) to .23 tons per day (October, 1969).¹⁶ The amount of sediment in the creek appears to increase with the rainy season, when water-induced erosion is at its highest.

The quality of surface water used by the Water District is generally good, although it does have varying degrees of hardness. Water delivered to the ACWD from the Hetch-Hetchy aqueduct has an average hardness of 20 ppm, and water from the Calaveras reservoir has hardness of 110 ppm. Both are usable, although the District operates softening facilities to remove excessive hardness.

Since the establishment and maintenance of water quality is most often a regional matter, concerning the entire basin, Fremont should take the position of understanding problems that may arise and support the efforts and programs of regional agencies to overcome the problems. Where water quality relates to supply (such as water pollution problems during times of low stream flow), the City should be aware of the implications of the entire system throughout the watershed for local water users; if intercity coordination is needed, it may have to be stimulated by Fremont.

Problems of chemical and saline infiltration of the local groundwater supply have been discussed in the groundwater section. It should be pointed out here that the presence of both Nitrate and Boron concentrations east of the Hayward Fault rule out the protective role that the fault seems to play in preventing saline water from migrating from west to east of it. In order to reduce the problem to acceptable levels, the City will have to insure that the sources of these two chemicals are kept to a minimum: in the case of Nitrate, septic tank fields should not be allowed in or around the City, nor should accumulations of Nitrate-producing organic waste be permitted. Since Boron seems to be a product of the geologic makeup of the area, little can be done about the problem other than to seek other sources of supply, which the Water District is doing. These problems further point up the need to investigate the implications of continued urban expansion for local and regional water supplies, since even if the Niles Cone were reclaimed from brackish water intrusion, chemical concentrations could lessen the future usefulness of the water for local domestic use. These matters demand further study, which the City, Water District and other concerned agencies should proceed to carry out at the earliest opportunity.

FOOTNOTES

1. A "watershed" can be defined as an area enclosed by topographical divides such that water introduced to the area will normally drain by gravity to a point within that area.
2. U. S. Army Engineers, San Francisco District, "Draft EIR, Alameda Creek Flood Control Project," April, 1973.
3. U. S. Geological Survey, Water Resources Data for California, 1971.
4. "Gradient" can be defined as the slope of a line joining the elevations to which water would rise in pipes freely vented to atmospheric pressure.
5. Alameda County Water District, "Survey Report on Groundwater Conditions," February, 1973, p. 2.
6. Ibid, p. 7.
7. Ibid, p. 13, 1972 "Survey on Groundwater Conditions," p. 13.
8. 1973 "Survey," plates 4 and 5.
9. Jones and Stokes Associates, Inc., "Draft Environmental Impact Report on the Alameda County Water District Aquifer Reclamation Program," March, 1973.
10. Memo from General Manager to Board of Directors of ACWD, "Analysis of ACWD Area Water Supply requirements," February 18, 1971.
11. Jones and Stokes Associates, Inc., "Draft Environmental Impact Report on the Alameda County Water District Major Facilities Improvement Program," March, 1973.
12. ACWD Board of Directors' Resolution No. 1893, January 28, 1971.
13. Most of the information for this chapter was provided by the Alameda County Flood Control and Water Conservation District, which manages these zones in providing surface water management to residents.
14. U. S. Geologic Survey, "Map Showing Areas in the San Francisco Bay Region where Nitrate, Boron, and Dissolved Solids in Groundwater May Influence Local or Regional Development," by D. A. Webster, Miscellaneous Field Studies Map MF-432, 1972.
15. Ibid.
16. U.S.G.S., Water Resources Data for California, Part 2, Water Quality Records, 1970, pp. 166-167.

MINERAL RESOURCES

Introduction

Information on mineral resources in the City of Fremont is general in nature, but nevertheless, City policy makers can use it to gain some insight into the impact, upon these resources, of planning decisions.

Two principal data sources are used: the California Division of Mines and the United States Geological Survey.¹ Information from the latter source is still in a preliminary, unpublished form and consequently should be considered in only a general sense until final publication (probably in late 1973) occurs.

The following pages will briefly discuss the nature of mineral and quasi-mineral deposits in the City. Sand and gravel, stone, salt, and several related resources will be analyzed, from both a local and a regional perspective. The concluding pages will provide some general recommendations about the City's attitude toward mineral resource preservation and/or use.

An additional important factor to be kept in mind is that there appears to be no significant amounts of "rare" or "valuable" minerals (such as gold, silver, mercury, lead, etc.) in the vicinity of the City. All identified resources are common, but are still important to the City, especially since many of these resources are vital to the economic activity of the Bay Area.

Sand and Gravel

The sand and gravel industry in California is among the nation's largest, since there is a large amount of construction activity in the state. The building of roads, public works projects, concrete structures, etc., requires large amounts of high-quality sand and gravel. Bay Area construction activity has paralleled the economic growth of the region and state, and ever-increasing quantities of sand and gravel are being required to support this growth.

Most sand and gravel used in the Bay Area is produced in the region. The tonnages used are obtained primarily from shallow alluvial cone deposits of the Alameda Creek basin in the Niles-Centerville area of Fremont, and from valley fill alluvium along Arroyo del Valle and Arroyo Mocho in the Livermore-Pleasanton area. In commercial terms, "sand" refers to rock or mineral fragments ranging in size from .003 inches in diameter to .25 inches in diameter; "gravel" consists of fragments larger than .25 inches in diameter up to 3.5 inches in diameter. Both are used as aggregate in cement and asphaltic mixtures, for subgrade roadbeds, etc. Both are relatively expensive per unit of value to transport (the present economic limit is about 40 miles²). As

FREMONT GENERAL PLAN CONSERVATION ELEMENT

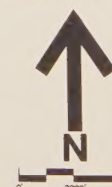
MINERAL RESOURCES

LEGEND

-  GENERAL AREA OF SAND OR GRAVEL DEPOSIT
-  GENERAL AREA OF CONGLOMERATE ROCK DEPOSIT
-  QUARRY - CURRENT USE PERMIT
-  QUARRY - EXPIRED USE PERMIT
-  SALT PONDS
-  SALT REFINERY
-  CLAY PIT
-  HOT SPRING
-  GENERAL AREA OF SHELL DEPOSIT

CITY OF NEWARK

FREMONT CITY BOUNDARY



MAP 6

SOURCE: U.S.G.S., Calif. Div. of
Mines and Geology,
City of Fremont.

THIS MAP IS ONE OF SEVERAL WHICH ACCOMPANY THE
TEXTUAL MATERIALS OF THE CONSERVATION ELEMENT
IN THE FREMONT GENERAL PLAN. IT IS INTENDED TO
ILLUSTRATE THE CONCEPTS AND PROPOSALS OF THE
OF THE ELEMENT, AND SHOULD BE USED FOR GENERAL
PLANNING PURPOSES ONLY. PRECISE PLANNING DATA
MUST BE USED TO SUPPLEMENT THIS INFORMATION AT
THE TIME OF PLAN IMPLEMENTATION.

a result, demand tends to concentrate near the areas of greatest population growth, which includes the East and South Bay areas.

Current extraction activities in Fremont takes place at four major quarries; three of these are located along Alameda Creek (see Map 6) and the fourth is found in the Mission San Jose area. The first three produce an estimated two million tons of material annually,³ and the fourth quarry has an approved City use permit to remove about 3.5 million cubic yards of sand along a ridgeline. All four are open-pit type quarries, and use permits for them include requirements for site rehabilitation upon the ceasing of operations.⁴ The total land area occupied by the four sand and gravel quarries is about 600 acres.

The U.S.G.S. has tentatively identified a vast sand and gravel deposit in the Fremont area which dwarfs those presently covered by City use permits. The area is shown on Map 6; it appears in two different parts of the City. The first occupies about 3500 acres west of Niles Canyon, and the second covers about 1000 acres southwest of Mission San Jose. The U.S.G.S. has estimated that the deposits contain around 612 million tons of readily available (with less than 25 feet of overburden between the surface and the deposits) material.⁵ Since the areas are only tentatively identified, and data on them has not yet been published, it is difficult to develop precise recommendations toward their use or to assess the consequences of their location in the City. These actions should await the publication of the Basic Data Contribution document later this year. It is obvious that the demand in the region for these sand and gravel deposits will have an impact on the City. This impact could occur in the form of increased pressures for exploitation of the resource (which effectively precludes other uses of the land), until it is priced high enough to economically justify such use. Given these conditions, potential environmental impacts are great, and the City would have to carefully consider the effects of allowing these deposits to be extracted.

Because of the current availability of sand and gravel in the Bay Area, the land areas noted above presently have more economic value for other types of use, including urban uses, than they do for quarrying. The fact that the areas are located in the path of urban growth (parts of them are already covered by the City) lessens the chances of the deposits being used in the near future, if at all, unless demand becomes great enough to price sand and gravel-bearing lands higher than lands for urban development. The U.S.G.S. has predicted that by the year 2000, readily available sand and gravel resources in the region may be exhausted (given anticipated construction trends) and material will have to be imported, which will drive the price up. Whether or not this will lead to strong pressures to use Fremont's resource remains to be seen, but the City should look into the matter in more detail and begin to formulate a means to cope with the question when it arises.

Crushed and Broken Stone

Production of crushed and broken stone is one of the oldest and most extensive mineral-related industries in California. Evidence of extensive quarrying for stone is found throughout the Bay Area. Most of this material is used as aggregate in asphalt paving, subgrade roadbed material, and foundation material.

Quarries of crushed and broken stone are located wherever it can be economically extracted from the earth's crust. In Fremont, the hill areas, see (Map 6), which are composed primarily of the Franciscan assemblage (see Geology section), are rich in conglomerate, which consists of folded or broken sedimentary rock with abundant fragments of pebble or larger size in a matrix of sand and finer grained materials.⁶ This conglomerate is a basic source of material for the crushed and broken stone industry.

Such stone, like sand and gravel, must be located close to the market. In the past, the market and the industry has tended to concentrate in the northern areas of the region: Oakland, San Leandro, Hayward, etc. As the southern portions of the region continue to grow, pressures for industrial expansion in the vicinity of Fremont will increase.

There are presently two stone quarries in Fremont (see Map 6): Bellini and Leslie. Since its incorporation as a city, Fremont has had a total of 12 such quarries. The limit of production is stipulated by the City in the rehabilitation plans for the operations, which indicate the condition the site must be in when the quarries close. A very general estimate of the amount of stone these quarries will have removed upon reaching their approved limits is 10 million cubic yards. Rehabilitation efforts are to center around recontouring the sites, replanting trees, grading, etc., for future development or open space.

Because much of Fremont consists of materials from which stone can be quarried, demands for the commodity will be everpresent, and (as noted above) may well increase. The stone resource base in the City is more than adequate to meet anticipated needs, although the impacts of additional quarrying may be serious enough to result in limitations of the location and extent of the activity.

If stone quarries are to be developed in the future, the City will have to take actions to insure that adverse environmental impacts are held to a minimum, and that complete restoration and rehabilitation of the sites is accomplished upon completion of operations. Future quarries should be located in areas of the City where few land use conflicts are likely to occur, and should be placed, as much as practicable, out of sight of most of the City's land area. One practical way to determine the appropriate locations is to study in advance the likely demand for stone and tentatively reserve sites where this activity can take place well in advance of actual demand. This, along with strong regulations governing restoration of the sites, will give the City ample

tools to allow a use of this resource and at the same time protect the quality of the environment and of urban life.

Salt

Salt is one of the basic necessities of human life. It is a vital element of diet, as well as being a preservative and flavor-enhancing agent. It is also important to many industrial processes. For these reasons, the salt industry is one which can persevere throughout the foreseeable future.

Salt is produced in several ways. Rock salt is mined in bulk in many parts of the world. Artificial brines are produced and salt extracted from them. In some areas of the world, including the less industrialized regions, salt is produced through solar evaporation, which is a historic method of production.

In the Bay Area, solar evaporation has been modernized and perfected, due to the influence of three major factors: climate (dry, warm, windy summers which speed evaporation), land (thousands of acres of low-lying salt marsh create ideal evaporation pond sites), and market (domestic and industrial consumption — in California, industry uses 65% of all salt produced in the Bay Area). As a result, salt production is a major industry in Fremont, and serves a large and ready market in the Bay Area.

Two companies produce salt in the South East Bay Area: Leslie Salt Company and Oliver Brothers Salt Company. Leslie is responsible for 99% of total production in the area. Total annual production is around 567,000 tons within the City proper, and about 1,107,000⁷ tons in the Bay Area. The Oliver produces about 1% of the total, or 13,200 tons annually, none of it in the Fremont area. Leslie owns about 13,000 acres of salt ponds in Fremont, and Oliver owns none in the City.⁸ Map 6 shows salt pond location in Fremont.

Fremont plays a major role in salt production for both the region and state. The 567,000 tons produced annually amount to 42% of total Bay Area production, 34% of the state's total production, 2% of total national production, and .6% of the world's production.⁹ The larger consumers of salt in the nation are chemical industries which account for about 65% of total consumption; household salt, including table salt, accounts for only about 3% of total consumption. Theoretically, future supplies are considered, to be almost unlimited due to the ocean and large inland salt deposits, there is a practical limitation for industrial users because salt has a relatively high transport cost, and loss of supply near industrial operations could result in higher production costs or cutbacks in operations. The bulk of California's industry which uses salt depends on local solar evaporation production, most of which is in the Bay Area. This dependence is likely to persist, making local salt production a local and regional resource of considerable value.

Salt ponds also constitute an important wildlife habitat. These areas are essential to the survival of many species of wildlife, including shorebirds, snails, insects, mussels, fish, shrimp and so on. The newly-established national wildlife refuge, which includes nearly all of Fremont's salt ponds, allows continued production of salt through solar evaporation, since the ponds blend well with the overall purpose of the refuge. It is also true that salt marshes — which the ponds have replaced in many areas — and tidal flats also provide important habitat for plant and animal life. The relative benefits of salt marsh vs. salt ponds is a subject of some debate; it has been suggested that the latter are more conducive to a "natural" ecological cycle of the type historic to the Bay. For this reason, it can be recommended that the salt industry be encouraged to continue because of its importance to the City and region, but that lands not functioning well as salt ponds be allowed to revert to salt marsh or tidal flat.

Other Mineral Resources

Aside from large-scale deposits of, and production of, sand and gravel, stone, and salt, there are certain mineral or quasi-mineral resources which have a potential for future use in the Fremont area. These resources include clay, mineral springs, and seashell (limestone) deposits, and will be briefly discussed below.

There are several types of clays, depending on the characteristics of the material: color, fineness, etc. Clay is valuable, and has been extensively used throughout history, because of its property of becoming plastic and easily worked when moist and of becoming hard and immune to moisture after prolonged heating in a kiln. It is used for cookware, pipe, roofing tile, and a number of other uses. Its chief virtue is that it is inexpensive to produce in finished form, and lasts a long time when properly manufactured.

No detailed state-wide information on clay deposits and potential resources is available. A soils map of the state will show that large reserves of miscellaneous clay appear to be present. As with other mineral resources found in Fremont, proximity to a ready market — the Bay Area — is of prime importance. As the area's population continues to increase, and demand for clay products grow, the industry can be expected to remain economically viable. Fremont presently has two pits where clay is extracted (see Map 6). These were pre-existing uses before City incorporation and have not been subject to City control.

Fremont has two hot mineral springs which have been identified by the U.S.G.S. as having regional significance.¹⁰ One is in a canyon north of the Niles area near an operating rock quarry, and the other is at the historic Warm Springs hotel-Stanford Winery complex in the Warm Springs area (see Map 6). The Warm Springs site was, in the early 19th century, a thriving spa known for the "healing" properties of its water. The 1868 Hayward earthquake is said to have changed

the flow and temperature of the water, but the resort is still operating, with the 96°F water being used to fill the swimming pool of the resort and water the lawns. The precise location and extent of the Niles area springs are not known; the general location was determined to be in the same canyon as the Bellini quarry.

Other hot springs may exist in Fremont along the Hayward fault corridor. They are a valuable resource for recreational use, and may have value for their mineral content (many hot springs are sulfur-based). Also, hot springs are being explored as a potential source of geo-thermal energy, although it is doubtful that Fremont's resource is of an extent suitable for this use.

In its yet-to-be-published study of Bay region resources, the U.S.G.S. has indicated that large quantities of limestone may be located in the City, beneath the Bay itself. According to the agency, the entire Bay floor within the City limits may be underlain by quaternary seashell deposits (see Map 6) to a magnitude of possible importance to the entire region. These deposits have been exploited in other portions of the Bay Area, but those in Fremont are as yet untouched.

California's limestone reserves are very large and are more than adequate for the foreseeable future.¹¹ But, as with sand and gravel, transportation costs are a major portion of product costs. Since limestone is central to the production of cement, sources of the material must of economic necessity be close to markets; a local supply is therefore important to the Bay Area. It is estimated by U.S.G.S. that present local sources of limestone may be exhausted within the next decade or two, and new sources may have to be found if present demand trends persist. At that time, demand may grow for exploitation of Fremont's resource.

The Bay lands are, of course, not presently available for such use: both the presence of the wildlife refuge and the regulations of the City and BCDC prohibit mining of limestone deposits, unless specific permission is granted. The environmental impact of such activity would be vast, and it is questionable that it would be permitted unless compelling reasons existed. These reasons may or may not occur in the form of economic pressures; the City should further explore the issue and determine future policy toward it.

Summary and Recommendations

The preceding pages have outlined the numerous existing and potential mineral and mineral-related resources of the Fremont area. It can be concluded that the most important existing resources (which are presently being exploited to some degree) are crushed and broken stone, sand and gravel, and salt. The remaining resources have, as of yet, marginal value and may or may not be exploited; much depends on the nature of the regional and national markets, production trends, the economics of production, and the City's attitude toward use of its resources for not only local but for area-wide markets.

The impacts of resource production are obvious, and have been mentioned throughout the report. Any mining or extraction operation will leave a scar on the surface of the earth, often a permanent one. The City has responded to this by requiring, with mixed success, full rehabilitation plans and monies for restoration of existing quarries upon the ceasing of their operations. In view of the large resource base tentatively identified in the City by U.S.G.S., it seems prudent to suggest that policy toward increased mineral production be defined well in advance of demand; if such demand occurs, the City will be prepared, and if not, little has been lost. Therefore, the following recommendations can be made:

1. The City should continue to accumulate information about the extent and value of its mineral resources, especially in reference to those for which regional or local demand may increase markedly in the next few years (sand, stone, salt); this will provide a sounder base on which to formulate policy and make decisions.
2. Any proposal for quarrying should be considered as having a significant environmental impact and should therefore go through the full EIR review process.
3. Local salt production should be encouraged, in view of the vital place the salt production industry has in overall industrial activity in the City, region and state; however, conversion of salt ponds to other than conservancy and open space uses (this in view of their strategic location as wildlife habitat) should be resisted — when salt production ceases in an area, salt marsh should take its place.

4. The City should continue to explore the alternatives before it in terms of whether it should reserve potential mineral extraction sites or should permit their development into other types of urban uses; this is an especially critical issue in connection with future sand and gravel demands and the location of the deposits within the urban sphere of the City. Basic decisions about the disposition of these lands will have to be made and implemented through the planning process.

FOOTNOTES

1. California Division of Mines and Geology, *Mineral Resources of California*, 1966 (Bulletin 191). United States Geological Survey, "Mineral Resources of the Bay Region," unpublished draft Basic Data Contribution, 1973.
2. Division of Mines, p. 362.
3. City of Fremont, Redevelopment Plan, Niles Quarry
4. City of Fremont Rehabilitation Plan, Sands Quarry
5. U.S.G.S., *op. cit.*
6. Division of Mines, pp. 392-393.
7. Leslie Salt Company letter from John S. Blacklock, Assistant Manager, Land Department, August 9, 1973.
8. Salt industry statistics are from Division of Mines, *op. cit.*, pp. 356-361.
9. Ibid.
10. U.S.G.S., Unpublished BDC
11. Division of Mines, *op. cit.*, p. 231.

ECOLOGICAL RESOURCES

Introduction

This chapter will deal with that portion of the natural environment of the City that makes up the overall ecological system. "Ecology" is defined as the science which deals with the relationships of living things to one another and to their environment. An ecological system is, therefore, a community of living things, each of which interacts in some way with the others of the community and with their immediate environment (land, sea, soil, etc.).

Various ecological systems within the City will be discussed within the context of available data. Plant life will be examined, and various zones, or communities, of plant life identified. Animal life will also be discussed, and its relationships to plant life in various zones will be dealt with. Where data is available, particular emphasis will be given to those types of plant or animal life which bear special significance for the City and which should be protected from the impact of development.

Ecological Zones

Three distinct ecological zones exist within the City of Fremont: the Baylands, the grasslands (flatlands), and the hill areas. Within these broad zones are numerous smaller zones, each with its own set of natural conditions that support certain forms of life. Because of the complex interweaving of plant and animal life in each of these zones, they will be discussed together rather than separately. Figure Five illustrates the concept of a food web and ecosystem which demonstrates the relationship between plant and animal life within a habitat.

Baylands

Since Fremont's boundary extends to the middle of the Bay, the baylands constitute a sizable area. The five major types of wildlife habitat found in the Fremont baylands are salt ponds, salt marshes, tidal flats, upland and open water. They are essential for birds migrating along the Pacific Flyway, as well as for countless other birds that depend on the bay throughout the year. A report prepared by the U.S. Department of the Interior, Bureau of Outdoor Recreation, in July of 1971, entitled **San Francisco Bay National Wildlife Refuge — A Proposal**, gives a description of the baylands habitats:

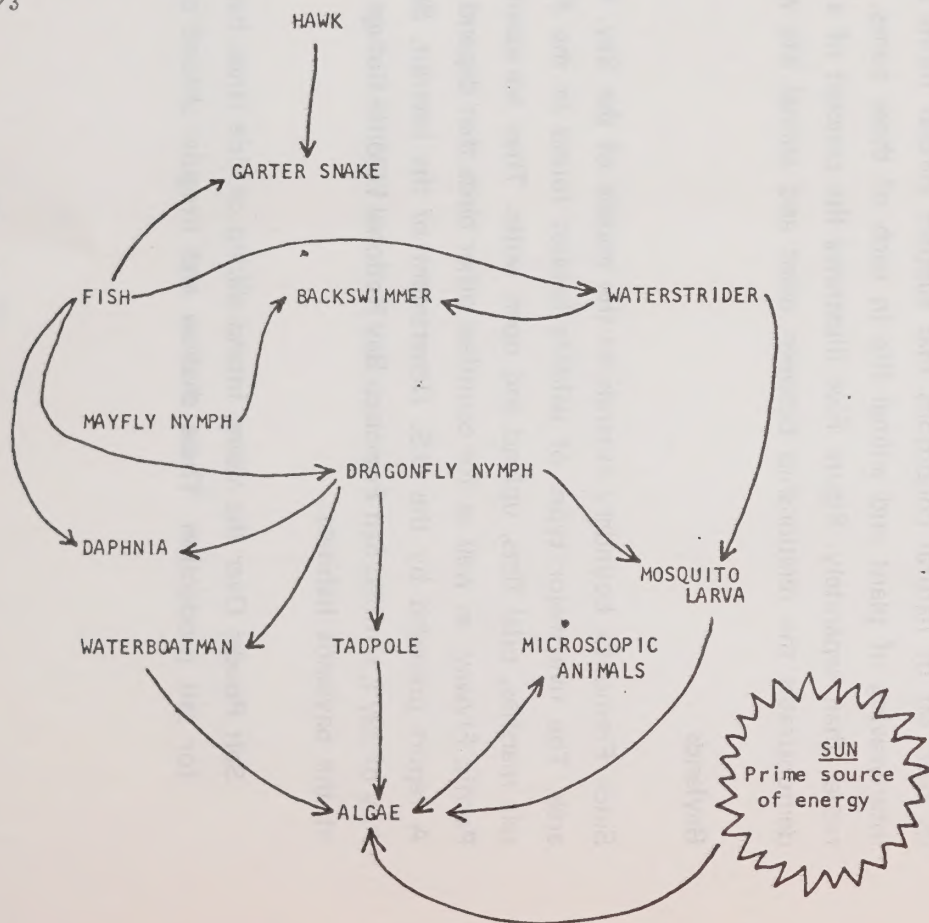
Salt Ponds: Over the years, inland diking of tide lands has formed solar evaporation ponds for salt production. These shallow and irregular shaped ponds averaging 300 acres in size

SOURCE:

Yee, Gilbert,
A Teacher's
Practical
Guide and
Handbook
to the
Natural
History of
Central Park
(unpublished)
1973

FOOD WEB IN A POND

A simplified pond or stream food web with arrows pointing to what the various animals eat. This food web is one example of an ecosystem



THE ECOSYSTEM

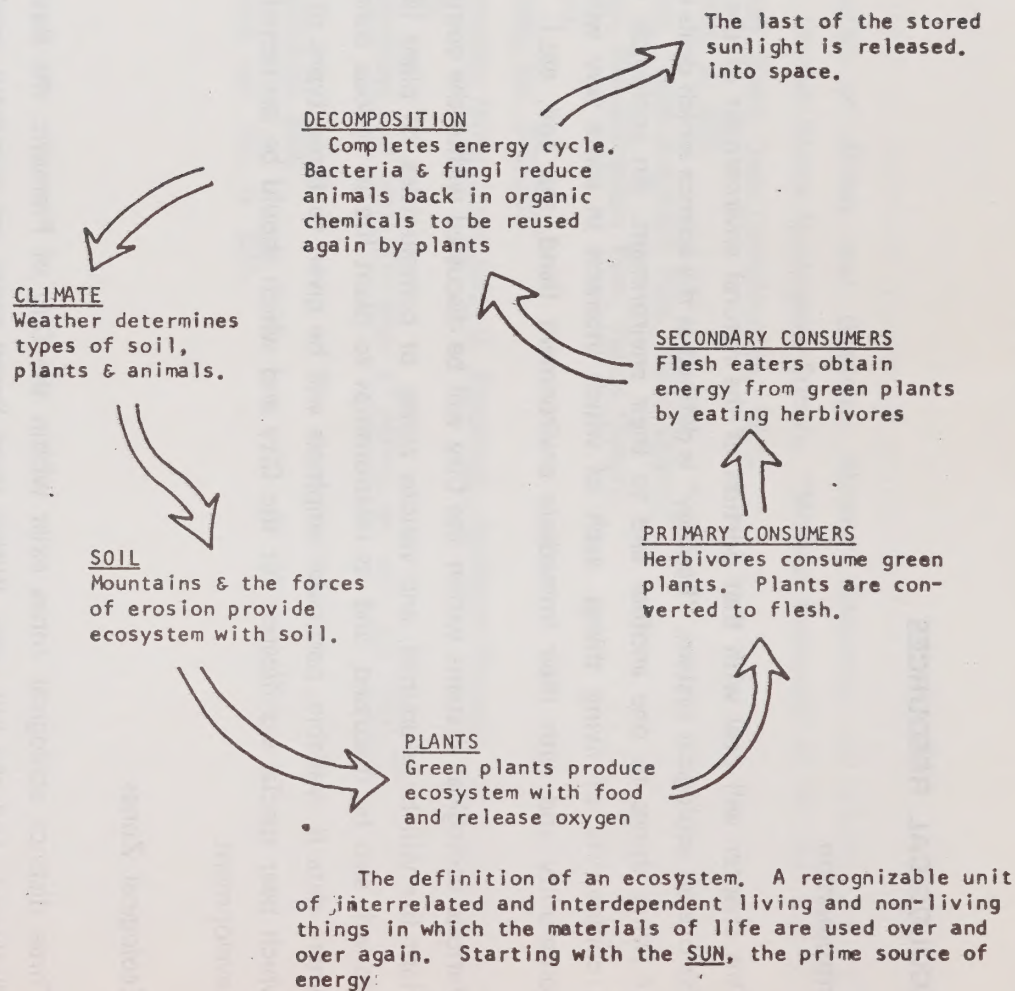
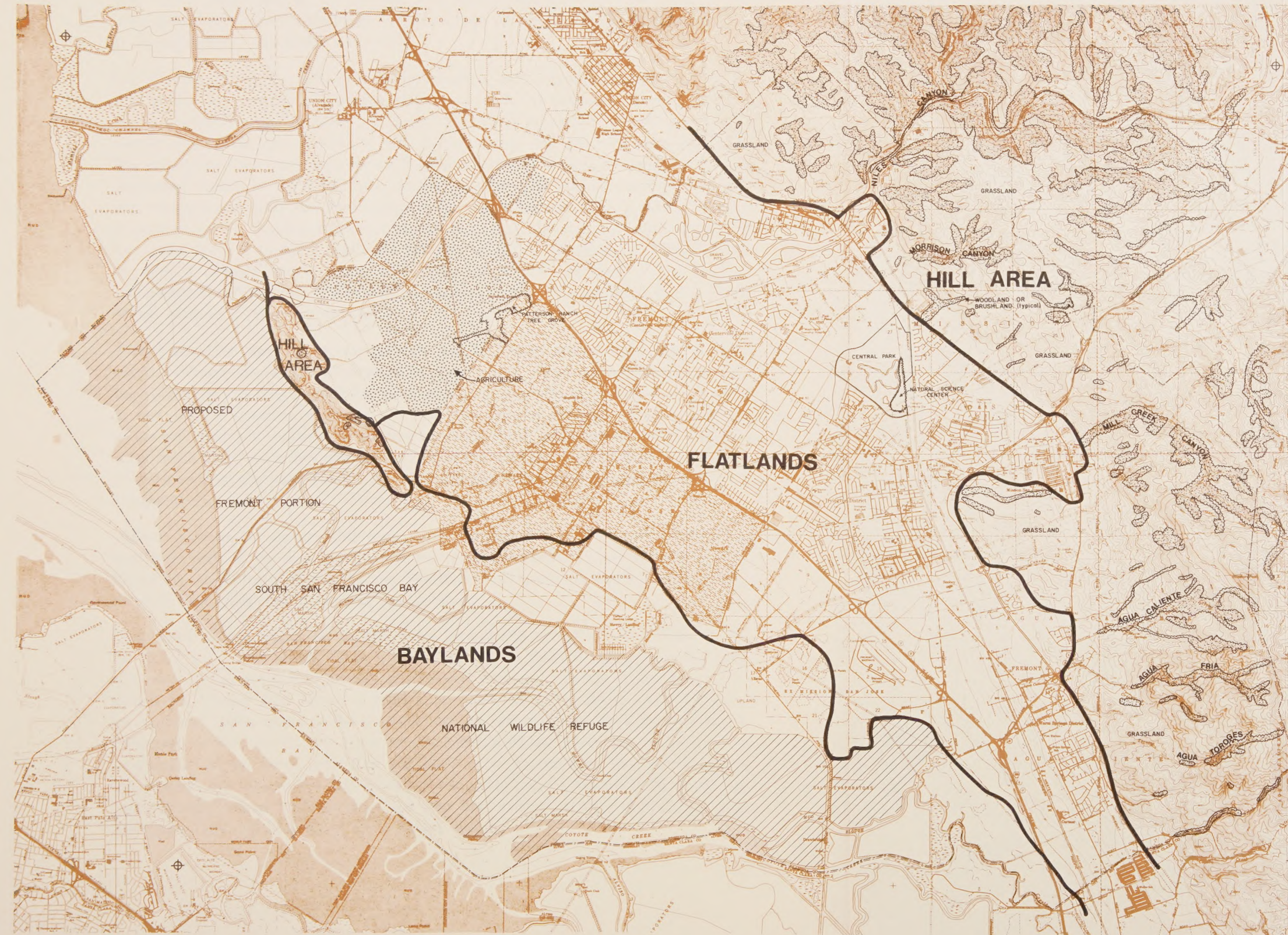


FIGURE 5

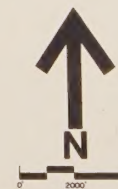
FREMONT GENERAL PLAN

CONSERVATION ELEMENT

ECOLOGICAL RESOURCES



CITY OF NEWARK



MAP 7
SOURCE: CITY OF FREMONT

THIS MAP IS ONE OF SEVERAL WHICH ACCOMPANY THE TEXTUAL MATERIALS OF THE CONSERVATION ELEMENT IN THE FREMONT GENERAL PLAN. IT IS INTENDED TO ILLUSTRATE THE CONCEPTS AND PROPOSALS OF THE OF THE ELEMENT, AND SHOULD BE USED FOR GENERAL PLANNING PURPOSES ONLY. PRECISE PLANNING DATA MUST BE USED TO SUPPLEMENT THIS INFORMATION AT THE TIME OF PLAN IMPLEMENTATION.

are used extensively by certain species of birds for feeding and resting, particularly during high tide or rough weather. Current salt pond management encourages the production of brine shrimp and other invertebrates, which are food for water birds and diving ducks such as scaup, redhead, canvasback and ruddy.

Salt Marshes: Salt marshes are one of nature's most productive natural communities. Through tidal action, vast amount of nutrients from marsh lands are passed to the mud flats and nearby shallows to support plant and animal life. Marsh vegetation provides feeding and nesting areas. Birds such as forster's tern, avocets, grebes and willets frequent the marsh. The endangered California clapper rail and the Alameda song sparrow, a depleted song sparrow subspecies, depend on the marshes for survival. Meadow voles may be found on the levees and nearby marsh areas and the endangered salt marsh harvest mouse normally frequents pickleweed marsh. Growing evidence indicates that marsh plants change carbon monoxide into other chemical forms to reduce the potential hazard of this toxic gas. The salt marsh not only is valuable wildlife habitat and a vital link in the food chain of the Bay, but also plays an important role in the health and welfare of man. The oxygen producing ability of salt marshes is especially noteworthy.

Tidal Flats: Tidal flats vary in composition from soft soggy areas to sand, shell and fine gravel. Although they appear unattractive to many people, these flats are important to the Bay's life cycle and play a significant role in providing oxygen to the water for maintenance of fish and the reduction of pollution. Food from marshes and open waters is deposited in the tidal flats and supports the abundant mussels, clams, snails, worms and insects upon which shore birds feed at low tide. Nearly 70% of the migratory birds of the Pacific Flyway, at some time of the year, depend on the South Bay tidal flats for food and related life requirements.

Upland: Uplands are the dry land areas above the high tide mark and are inhabited by land birds such as the song sparrow and the redwinged blackbird. Coyote brush used by herons and egrets for nesting grows here. The endangered California least tern nests on bare dikes or new spoils sites on or near the bayshore.

Open Water: Loons, grebes, cormorants, terns, canvasbacks and other diving ducks feed in the South Bay's open waters. There is great potential for fishing in the Bay. A few years ago, sport fishing disappeared because of pollution. Recently, however, improved pollution control has allowed sport fishing to make a comeback. Major limitations on fishing today are restricted public access to the shoreline and the lack of fishing piers. Sloughs are not considered as one of the five major wildlife habitats of the South Bay because of the combination of salt marsh, tidal flats and open water. Nevertheless, they are valuable as fish habitats and as a harbor seal nursery. Seals nearly became extinct in the South Bay until improved sewage treatment improved their environment and food supply. Now some 200 harbor seals are now found along Mowry slough.

Fortunately, most of the baylands are now included in the San Francisco Bay National Wildlife Refuge. The Refuge has been approved by Congress and funds authorized, but not all land has been acquired. The portion of the refuge in Fremont is broken into two units. The Mowry slough unit has a mixture of major habitat types and provides outstanding fish and wildlife benefits. Salt pond dikes form the only solid land. Harbor seals, about 200, have chosen the relative isolation of Mowry Slough as their nursery and resting area. Shorebirds feed undisturbed on the salt ponds and mud flats. Waterfowl use on the six salt ponds and adjacent Bay is substantial. California clapperails, harvest mice and song sparrows thrive in the marsh. Dumbarton Bridge forms the north boundary of this unit, with Coyote Creek slough to the south, salt pond levees to the east and the Bay on the west. The unit includes 3,445 acres of salt ponds, 1,611 acres of salt marsh, 1,646 acres of tidal mud flats and 473 acres of open water.

The east boundary of the Fremont unit abuts Coyote Hills, with Coyote Hills slough forming the north unit boundary. The Dumbarton Bridge Road (Highway 84) delineates the south line and Coyote Hills border salt ponds on the east. The unit ends at the Alameda-San Mateo County line on the Bay side. The many salt ponds provide food and sanctuary for thousands of shorebirds in the Fremont unit. Heavy use of the ponds by scaup ducks occurs during the late Fall and Winter. Brine shrimp and other foods are abundant. Some of the best mud flat feeding areas in the South Bay are within this unit and canvasbacks, scaup, scoters and redheads feed here. The unit is composed of 2,587 acres of salt ponds, 141 acres of salt marsh, 1,775 acres of mud flats, 30 acres of uplands and 717 acres of open water.

While the refuge will cover a vast area, there may be sensitive areas immediately adjacent to the wildlife refuge. Development in these periphery areas should be carefully considered and subject to full environmental impact review.

Flatlands

The vast majority of the remainder of the flatlands are developed into urban uses. Outside of the baylands and hills, few large flat, open areas supporting significant natural habitats exist. There are, however, exceptions. The Northern Plain, particularly the area west of Alvarado Boulevard, contains some of California's prime (Class I and II) agricultural land. As discussed in the soils analysis, its value for agricultural production outweighs any value it may have for wildlife or vegetation habitats. Two significant habitat areas in the Northern Plain are Coyote Hills and the Patterson Eucalyptus grove. Coyote Hills is in the East Bay Regional Parks System, but the Eucalyptus grove is not in public ownership. However, the City's Tree Preservation Ordinance provides some protection for preservation of this significant landmark. Additionally, the East Bay Regional Park District has identified this grove as being of regional recreational significance, and has published information indicating its high priority for possible purchase.

A third area in the flatlands with natural characteristics worthy of discussion is the City's Central Park. Although the park is highly developed for recreational purposes, it provides a living area for wildlife. The bird list in Appendix B points out the different varieties of birds that have been seen in Central Park. Also located in the park is a Natural Science Center, which comprises a distinct habitat within the City. The study area is a wooded, slow-moving stream that has raised boardwalks for observation purposes. The study area is typical of a riparian habitat which can occur on flatlands near bodies of water. It is valuable to the City, and provides an environment for a complex ecological community described below.

The dominant organism of this community is the Willow tree. The Willow's dense growth shades the lower levels, excluding all but a few shade-tolerant plants. Dense thickets of blackberry and poison oak vines flourish. These thickets provide a home for such solitary animals as rabbits, shrews and mice. Spiders also spin their webs among the leaves and birds hunt insects or eat the berries. The tall trees in the center of this wooded area are Poplars. Closely related to the Willows, they abound because of the rich soil and the water from the stream. The seeds of the Poplar and Willow have cotton-like tufts which carry them on the wind and furnish birds with nest material. The bull thistle, which may seem to be nothing more than a pesky weed, lives in the nature area and also has seeds which provide nest material. The Western Burreed provides leaves that the muskrat eats, and waterfowl feed on the seeds. Cattails, a close relative of the Burreed, house and feed many kinds of birds and animals in the nature area. Marsh wrens and redwinged blackbirds use last season's dry leaves to suspend their nests among this season's stems and leaves. When fresh cattails are seen floating across the stream, it is a sign of muskrats, which eat the root stalks.

Since the woody tissues of this small forest cannot be eaten by mammals, it is left for the termites, wood boring insects, bacteria and fungi. They perform one of the most important jobs by breaking down and decomposing the wood cellulose into simpler materials so that it can be reused by the living plants.

The concept of the food chain (see Figure Five) is clearly demonstrated in the Natural Science Area. It also shows what makes up a habitat. The damage that can be done by removing one link in that chain is obvious. For the ecological system to survive, each component within it must survive.

Hill Areas

The hills in Fremont support three habitats — grassland, which is most plentiful, bushland and woodland, which is common to canyon bottoms. The hills in Fremont contain mostly west-facing slopes, where grassland is particularly common. It also is prevalent in the form of interconnecting tongues extending along the major ridgetops. The grassland community is characteristic of hot,

dry slopes exposed daily to afternoon sun, as well as areas frequently subjected to strong winds and solar evaporation.

Grassland

Soil-supporting grassy vegetation may be remarkably thin in ridge crests and may be unstable, as on steeper slopes where sliding can occur. Grassland is made up of primarily exotic annual grasses, which are typically restricted in diversity but widespread in distribution. Due to a combination of heavy grazing and periodic drought, these alien species long ago replaced the local native perennial bunch grasses, as well as those on other ranchlands up and down the State. The annuals, completing their life cycle in a single growing season, escape the rigors of hot, dry summer months. Added to this are their high reproductive potential and their effective method of dissemination. Taken together, these are features against which overgrazed native perennials weren't able to compete. It is well to note also that grazing and drought favor grassland over the spread of other types of vegetation. Grazing and browsing by cattle, deer and other herbivores discourage the establishment of seedlings of woody plants, especially those weakened by drought, and in this way, help keep the boundaries of brushland and woodland in check.

The composition of the grassland is normally a mixture of wild oat, foxtail and various brone grasses, all annual species. Italian rye, a perennial, is present in lesser amount, and minor amounts of other annual grasses, as well as colonies of such perennials as bluegrass, are also found in the grassy hillsides. Aside from grasses, a number of other herbs are commonly members of grassland vegetation type. Mustard are abundant on open slopes, ridgetops and flats throughout the area. Milk thistle, bull thistle and sweet fennel are also widespread, especially along fire roads and transitional areas where grassland merges with other habitats. Lesser amounts of wild radish, teasel and dock are also to be seen. All of these forbs are naturalized species, introduced from Europe and now commonly found throughout much of California.¹

At certain times of the year, the open fields bring forth a fantastic array of showy wild flowers and other less conspicuous herbs. After the winter rains, the grasslands become dotted with the blossoms of California Buttercup, Blue Eyed Grass and the common Stork's Bill. Shortly, these are joined by the Brodiaeas, notably Bluedecks and Grassnut, and by late Spring, Mariposal Lilies decorate the ridges as does the California Poppy, which continues to bloom throughout the Summer. During the long days of July and August, scattered Morning Glories and Clarkias still add spots of color to the brown grasslands, and even with the approach of Fall, a few scarlet California Fuschia remain to bloom among the outcrops. A relatively large number of other species are associated with this vegetation type. A few of the less notable include Gum Plant, Yarrow

and Tarweeds, all of the composite or Aster family; also, Yerba Buena and Lotus are occasionally observed. Various kinds of shrubs are often interspersed in the grassland, Coyote Brush being the most common of these. Most of the shrubs, however, are more characteristic of the brushland vegetation type.

Brushland

Compared with grassland, the brushy areas constitute a fairly minor part of the hill area vegetation. Unlike grassland, brushlands have few characteristic distribution patterns that can be easily generalized in terms of exposure to a natural environment. Scattered across the hills, these shrub dominated zones often take the form of small well-defined patches found on slopes of various steepness and orientation on the crests of ridges or on the bottom of ravines and creeks. A number of the larger patches may inhabit fairly steep south and west facing slopes, but such is not always the case. It should be noted that brushland often covers the heads of ravines, which are commonly wooded in their lower parts, where the arroyos are adequately moist, especially if springs or streams are nearby. A variety of brushland plants will be found there, along with brushes and other plants requiring very moist ground. A number of relations exists between the shrubby areas and the neighboring vegetation types. Brushland is sometimes completely surrounded by either grassland or woodland, or it may be found where these two habitats merge with another. Also, certain shrub-dominated zones occur adjacent to cultivated land. In places, too, brushlands fully merge with the shrubby understory of woodland, producing a continuous ground cover that varies somewhat in composition, depending on the presence or absence of a forest canopy. Probably, the most single important element of brushland is Coyote Brush. In addition to being very widespread locally, it is capable of dominating brushy areas to the exclusion of other woody species.

Brush Monkey Flower is a frequent associate of Coyote Brush, as is Poison Oak. The brushy zone that often develops at the woodland-grassland interface is usually characterized by one or more of these species and, sometimes, by other shrubs such as California Sagebrush or Coffeeberry. Herbs, such as California Mudwort and Yarrow, are common. Brushland in slightly moister habitat and unshaded slopes along creek bottoms often contains an unusually high proportion of the following plants, in addition to the widespread species mentioned above: Toyon, Blue Elderberry, Blackberry, Creambush, Gooseberry and occasionally, Jimbrush, all shrubs. Also, herbs like Sweet Fennel, Bull Thistle and Bracken are found in this situation.

Woodland

A considerably large portion of the hill area can be classified as woodland. Although wooded areas are widely scattered throughout the hills, they are particularly characteristic of relatively

moist, sheltered and shaded habitats. These include stream bottomlands, like the creek in Morrison Canyon, and Mission Creek along Mill Creek Road. Rarely are the ridgecrests occupied by woodland. Although a number of factors are undoubtedly involved in preventing widespread woodland growth on the ridgetops, an important consideration is climate. In certain localities, trees growing near ridgecrests are grotesquely deformed and stunted, as well as expressing one-sided development arching of branches and the like. All these characteristics attest to the wind-turning effects of the prevailing westerlies. Such growth forms are part of the result of the wind-training of small branches to grow leeward, but they are also due to damage and destruction of exposed larger branches by the wind and to the abrasion and desiccation of young buds. More sheltered trees growing downslope are generally not as severely affected.

The interesting climactic features of the woodland forest canopy has a remarkable ameliorating affect on the micro-climate of the ground beneath, especially during periods of drought: surface temperatures are dramatically lower and relative humidity significantly higher than on open slopes. Further, obstruction of sunlight and trapping of air-pockets by the forest canopy contribute to an insulating effect which helps modify low temperatures near the ground. Avoiding the area's occasional subfreezing winter night-time conditions is of great importance to the herbaceous species, to seedlings and shrubs and trees, and to new growth of larger plants. The effect of the forest canopy varies the facings of the individual trees, which themselves can vary considerably.

Where the Oak woodland tends to be more open than the dense broadleaf evergreen forest the composition of the understory reflects the density and nature of the woodland canopy.

Woodland Biotic Communities

In general, woodlands represent a mixture of three different biotic communities, each with its own characteristic plant assemblage:

1. Oak Woodland
2. Broadleaf Evergreen Forest
3. Riparian Woodland

In some localities, these communities are well defined. However, a very large proportion of the woodlands is a blending of two or more of these communities. While certain species, such as Coast Live Oak, may be common to more than one woodland type, where inter-gradations among the different communities exist, mapping of units within the woodland becomes very complicated

and often loses meaning. The Coast Live Oak, a broadleaf evergreen medium size tree, is found in all woodland slopes and exposures and is the most common arboreal species at most locations. The California Laurel frequently grows with the Coast Live Oak and locally may dominate the woodland. Laurel is most regularly found on the lower hillside and canyon slopes and near creek bottoms, though far less common than Coast Live Oak and California Laurel. Although trees are obviously the dominant members of the woodland vegetation type, a shrubby understory is often prevalent. A considerable importance among the shrubs is Poison Oak, which grows as both shrub and vine. It occupies all types of woodland habitats from upper ridge slopes to creek bottomland, and at some stations becomes quite dense. Coffeeberry is another common woodland shrub, particularly so on the easterly interior ridges of the study area. In the Oak association area, it frequently dominates the understory. In contrast to Oak and grassy slopes, woodland areas are relatively rich in native perennial grasses. Alien annual grasses on the open slopes and ridgetops are also extremely prominent in parts of the woodland; one in particular, Silver Hairgrass even appears to prefer the relatively sheltered open woodland habitat. It should finally be noted that woodland areas do not usually cover extensive tracts of land without interruption. More frequently, they are mixed with lesser amounts of brushland or contain grassy clearings as boundaries.

Important woodland trees not previously described tend to be more restricted in number and distribution. Western Sycamore is almost entirely restricted to the moist stream bottoms. The California Black Oak is found on shady slopes of the interior ridges and the Blue Oak is a common foothill tree in California away from the coast. In addition to native species, certain introduced trees have become established in the hills and are now growing and reproduce without human interference. Specifically of the genus Eucalyptus, especially Blue Gum, are notable in this respect. The hillside groves of Eucalyptus along Vargas Road and Stanford Lane are representative examples. Shrubs are rarely found in the woodland, but Coyote Brush is often seen, especially near the edges of clearings. Other species include Blackberry, Bush Monkey Flower, Blue Elderberry, Queen Brush and Finger Berry, with lesser amounts of Toyon, Silverbrush Lupine, Honeysuckle and Gooseberry. Many of these reach down the slope to the creek bottom where they occasionally mix with the Royal Willow, Hazelnut and considerable amounts of Snowberry. In places where the woodland canopy becomes particularly dense, frequently into growth of California Laurel, shrubby understory is often reduced or less likely. Woodlands are amply supplied with native perennial grasses, including widely scattered Blue Wild Rye and colonies of needle grass, blue grasses and fescues, and brone grasses are well represented by annual and perennial species. In season, a variety of common and often colorful herbs are conspicuous in the woodlands. These include Chickweed, Milkmaids, Shooting Star, Woodland Columbine, Larkspur, Bedstraw, Yarrow, California Mugwort, Paintbrush, to name only a few. Also, ferns are frequently seen where

conditions permit, especially common among them is the Woodfern. Others that can be found are California Polybody and California Maidenhair, with gold-black fern and Coffee Fern growing in somewhat drier situations. Worthy of note is the fact that distinction exists between exotic or alien in cultivated vegetation. Virtually all of the most common grasslands forms as well as certain brushland and woodland elements are exotic; that is, they are not native to this area. Four of these alien species enjoy a self-sufficiency in they are able to grow and reproduce without human intervention. In other words, they have become naturalized, like some of the Eucalyptus.

Hill Area Canyons

Field surveys² were made of several hill area canyons, but those listed here should not be considered a complete list.

Niles Canyon: Typical of most stream canyons in this region through which Alameda Creek flows, has a mixed plant community. Along the stream channel is a riparian community containing such trees as Willow (*Salix*), Alder, Big Leaf Maple (*Acer macrophyllum*), Western Sycamore, and some Bay Laurel.

The canyon slopes display the usual pattern of mixed evergreen woodland on the northeasterly facing slopes and oak-grassland savannas on the southwesterly facing slopes. The southwest facing slopes also display areas of brush-chaparral plant communities.

Moving away from the stream riparian community on the north facing slope, the mixed Broadleaf Evergreen Woodland contains such trees as Bay Laurel, Coast Live Oak, Madrone, California Buckeye and Blue Elderberry.

Scattered among these trees are shrubs such as Toyon, Coffeeberry, Bush monkey Flower and Poison Oak.

Across the stream canyon on the southerly facing slope, the Oaks (Coast Live, Valley and some Interior Live) are the more prominent trees, though there are scatterings of others such as Bay Laurel. Generally speaking these southwesterly oriented slopes have a mixture of open grasslands with scattered oaks and areas of chaparral type shrubs containing Bush Monkey Flower, Coyote Brush, Sage, Poison Oak, Bush Lupine and Hillside Gooseberry.

The indicator animal life seen in Niles Canyon included the following: **Birds** - Scrub Jay, Oregon Junco, Brown Towhee, Mourning Dove, Turkey Vulture, Red Tailed Hawk and Finches. Though not seen, one can assume the following would also be found: Great Horned Owl, Screech Owl,

Pygmy Owl, Barn Owl, Anna's and Allen's Hummingbirds and Acorn Woodpecker. **Mammals** - Gray Fox, Western Striped Skunk, Opossum, Raccoon, Gray Squirrel and Black Tailed Jackrabbit. **Reptiles** - Gopher, Garter, King and Western Rattlesnake. **Wildflowers** - There are good displays of wildflowers along the south slopes of Niles Canyon containing such flowers as Blazing Star, Elegant Clarkii, California Fuscias, Yarrow, California Poppy and Bush Lupine.

Niles Canyon contains some excellent examples of Western Sycamore, Big Leaf Maple, Bay Laurel and Madrone. The stream and riparian plant community combine to make this canyon a pleasure to the eye and spirit. It should be kept in mind that this is the route for the extension of the Alameda Creek Regional Trail from the mouth of Niles Canyon to Sunol Valley Regional Park.

Morrison Canyon: The general description given for Niles Canyon would also apply to Morrison Canyon and Mill Creek Road areas. The riparian community is the dominant plant community, but there are scatterings of Broadleaf Evergreen and Oak grassland.

Morrison Canyon has extremely steep slopes from the mouth of the canyon to the canyon to the junction of Morrison Canyon Road and Vargas Road.

There is an excellent riparian plant community along the stream. The animal life here would be the same as that reported for Niles Canyon.

This canyon will provide a scenic route for a recreation trail to the proposed Vargas Plateau Regional Park, as any widening of the existing road could damage the existing canyon environment.

Morrison Canyon is an excellent area for wildflower displays. This spring saw some extensive displays of elegant Clarkii. One species of Wild Snapdragon, *Antirrhinum vagans*, is listed in Jepson, **A Manual of the Flowering Plants of California**, as only occurring in Morrison Canyon in this part of California.

Mill Creek and West Mission Hills: Most of Mill Creek Canyon also has very steep slopes. The road runs near the creek for most of the canyon length. Any attempt to improve the road would be a serious threat to the stream riparian environment.

The plant community is predominantly riparian along the stream channel. There are some excellent specimens of California Bay, Big Leaf Maple, Western Sycamore and Coast Live Oak within the

first ½ to ¾ mile from the canyon mouth.

Special note should be made of the ferns and small waterfalls located about ¾ mile up the stream. Woodwardia Fern, a rarity in the Fremont area, was seen there.

The canyon slopes display the typical plant communities of Broadleaf Evergreen woodland with Oak-Grassland savannas and shrub near the slope tops.

The two canyons in the West Mission Hills district are generally unsuitable for building due to the steepness of the slopes and unstable soil. It would be advisable that these canyons be retained as open space, perhaps becoming part of the city trails system. They are also potential sites for ecological study areas.

Ecological Resource Recommendations

This chapter represents the first time information has been compiled about plant and animal life in Fremont on a comprehensive City-wide basis; but it is far from being complete. The following recommendations aim to help keep and expand this section of the conservation data base:

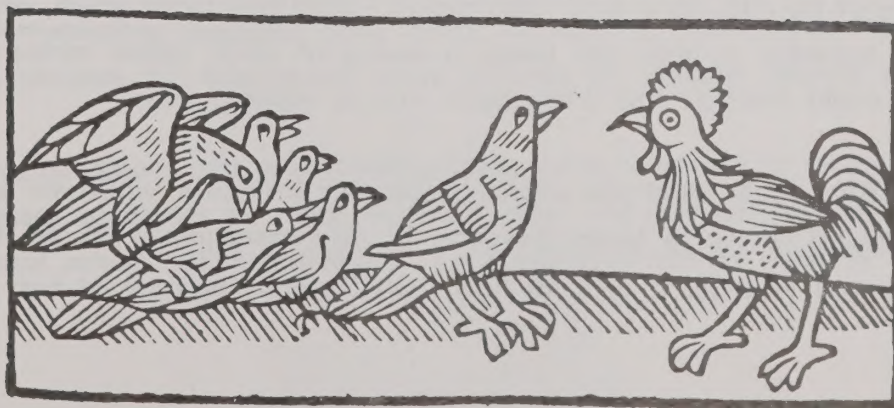
1. An Environmental Data Bank must be established that can be kept up to date concerning information on plant and animal life, as well as other environmental concerns. The information can then be used in the Environmental Impact Review process.
2. The City should hire a Park-Ranger Naturalist to aid in interpreting environmental data and to insure that a well-rounded natural science program is maintained.
3. Natural Science Centers and land for learning programs should be staffed by personnel qualified in the natural science field.
4. Any proposal to improve roadway access into the hill area, or provide new access, should give primary consideration to areas other than those that are designated as significant canyon environments.
5. The flatland areas bordering the Bayshore should be subjected to a thorough environmental impact analysis as to its effects on the Bay and especially the San Francisco Bay National Wildlife Refuge.

FOOTNOTES:

1. Information for this section is extracted from the previously-cited **Hayward Hill Area Study**. It should be noted that while the Hayward data generally applies to Fremont, specific differences may exist which require further definition.
2. Field studies of canyon areas conducted by Wallace Cromwell, Bob Tierney, Philip Holmes, Harry Stockey, Neil Evans; June-July, 1973.

Other Sources

1. Yee, Gilbert, **A Teachers Practical Guide and Handbook to the Natural History of Central Park**. (Unpublished)
2. City of Fremont, Department of Recreation and Leisure Services, (Dave Lewton) **Natural Science Center, Self-Guided Tour**. (Unpublished), 1972.
3. Letter from Walter Stieglitz, Refuge Manager, **San Francisco Bay National Wildlife Refuge**, dated October 1, 1973.



CLIMATE

Climate, as a function of weather trends, is not precisely a "resource" in the true sense of the word but is a controlling factor in many ways when land use is considered. For example, agricultural activity is highly dependent on climatic conditions: temperature, rainfall, winds and the like. These impacts are less noticeable on most urban uses, except where artificial modifications of climate are required for human safety and comfort; these are presently well within the technological capability of society, but do extract a cost, such as in the use of limited energy resources. Therefore, a summary discussion of climate is useful here and gives rise to some general planning recommendations.

Fremont is fortunate to have a Mediterranean climate of warm, dry summers and cool, moist winters. This condition is due to the proximity of the Bay, which acts as a massive moderator of temperature extremes. Most rain occurs between the months of November through March, and the rest of the year is relatively arid. Annual rainfall is variable, amounting to as little as 8-9 inches per year to as much as 30 inches per year.¹ The annual average is around 15 inches per year. Temperatures are variable within a relatively small range, averaging from about 45° during the cool season to around 90° during the summer (they rarely go above 90° during a normal season). Relative humidity ranges from 80-85% at night to around 65% during daylight winter days and around 55% during daylight summer days. Summer days are normally clear or slightly hazy and winter days are often overcast with low clouds or fog.

The most prominent characteristic of Fremont is the constant wind which occurs each afternoon from the temperature differentials between the land mass and the Bay. This wind blows from a northwesterly direction, off the Bay, at an average speed of nine miles per hour, and provides a strong cooling influence to the Bay Plain. Strong winds (35 mph to 85 mph) can be expected once every two years. In certain parts of the City, depending on topographic conditions, location of structures, foilage, etc., winds can reach higher speeds than the average. As the moving air masses strike the hills and are deflected upward, speeds can increase as friction induced by the valley floor lessens. Winds are especially strong across the ridgetops of the hills and give the more exposed portions a "scoured" appearance; wind action is partially responsible for the rolling, rounded shape of the hills. Wind action also creates a wind chill factor which, when temperatures are low and humidity is high, can create a feeling of much cooler temperatures than the thermometer might indicate; this is especially true to exposed areas.

The cooling effect of the wind also creates temperature inversions, which are layers of cool air next to the ground overlain by layers of warmer air. This phenomenon has the effect of trapping the cooler air and whatever it contains in a low-lying layer; at times of high pollution levels,

the layer can become quite visible as the pollutants are trapped below the inversion. The height of the inversion layer is often less than 1,400 feet MSL in summer, which allows the hills to trap the inversion on the plain.

Temperatures at the ground from solar heating can vary depending on time of day and on topography. Normally, the morning sun is not as hot as the afternoon sun, meaning that easterly-facing slopes will not receive the same amount of solar heating as westerly-facing slopes. This can affect the amount of moisture which evaporates from the soil, allowing easterly-facing slopes to retain more vegetation through less solar evaporation than westerly-facing slopes.² On the flatlands, these differentials do not occur, although surface temperatures vary depending on local topography and proximity to the Bay.

Some general planning implications can be extracted from this brief summary of climate and weather conditions:

1. Because the climate of Fremont is moderate, without extremes in temperature, few overwhelming problems occur because of it. Certain actions can be taken, however, to conform to the modest demands of the climate. These are as follows:
 - a. Homes should be insulated, due to the need for heating in cool weather and air conditioning in warmer weather; insulation would also reduce demand for dwindling energy resources while increasing comfort for inhabitants of dwelling units.
 - b. Development patterns should take account of wind direction and speed and seek to reduce its effect by avoiding the creation of "tunnels" (streets aligned with the prevailing wind, open plazas without windbreaks, numerous structures exposed to the wind without regard to air currents); this will lead to a more sheltered environment for urban dwellers.
 - c. Development on the westerly and northerly slopes of the hills will be exposed to the greatest extremes of temperature, wind, chill factor, heating and evaporative cooling, which could reduce the value of these areas for homesites unless compensating measures were taken in housing construction. Ridgetops will experience the most severe winds and may be unusable because of this.
2. Climatic conditions tend to concentrate smog layers in inverted air layers, which creates unpleasant conditions for residents of the plain. Fremont must support both regional and local actions which contribute to a lessening of the air pollution problem.

3. Because foliage has a marked effect on reducing wind, lessening temperature extremes, solar evaporation, etc., efforts should be made to plant appropriate stands of trees to serve as windbreaks, shelters, etc., where none now exist. This is especially true in flat, exposed areas, where wind causes not only discomfort but can create severe erosion problems for exposed soil.
4. Because most precipitation occurs during the winter, the storage of water and its control (for flood prevention, recreational or recharge purposes) is critical, and programs to accomplish these things must be supported by the City.



FOOTNOTES:

1. Alameda County Water District, "Monthly Precipitation Record," Niles Precipitation Station, 1870-1973.
2. Hayward Hill Area Study, p. 61.

The management of air resources is dependent on both local and regional activities and controls. Air resources themselves are clearly regional, since air cannot be confined to the boundaries of any Bay Area political jurisdiction. For this reason, air quality surveillance and pollution abatement authority must be vested in an area-wide body. The generation of air pollution, however, is local in nature, and can be materially affected by local land use and transportation system decisions. In the Bay Area, where automobiles are the major generator of air pollution, local decisions about the intensity of land use, the location of major destinations in relation to residential development, the design of streets and highways, and the choices of transportation available to the population determine to a great degree the amount of air pollution generated in each community. Of course, individual cities cannot resolve air pollution problems alone, even through the most judicious restraints on automobile usage. Fremont receives more than its share of the Bay Area's pollutants, due in part to climatic conditions. The prevailing westerly and northwesterly winds tend to blow much of the polluted air of the region toward the east and southeast Bay cities. Inversions (see Climate Section) tend to form on the Bay plain and trap this air. Regional pollution abatement procedures, implemented by the Bay Area Air Pollution Control District, are the means for dealing with this impact.

The Bay Area Air Pollution Control District (BAAPCD) is a regional agency, established in 1955, charged with the monitoring and control of air pollution sources within the Bay Area. Currently, its control activities are limited to industrial operations, open burning and similar "stationary sources" of air pollution, although it monitors motor vehicle air pollution and publishes statistical information on overall pollutant levels. No Federal regulations governing "complex sources" of air pollution will give the BAAPCD greater powers to control automobile use and traffic patterns in the Bay Area. The complex sources regulations, issued in June 1973 by the Environmental Protection Agency, require technical review of the probable air pollution to be generated by automobiles at major facilities such as large shopping centers, stadiums, large-scale housing developments and other destinations which attract large numbers of autos in relatively short time period with agency disapproval of facilities which will generate air pollution in excess of air quality standard. Close cooperation between the BAAPCD and local government planning functions will be necessary to assure that local needs and preferences are not disregarded under the new regulations and that a comprehensive perspective is maintained in local land use decisions.

There are several distinct types of air pollution, which can be defined in summary language:¹

1. Particulate Matter: This consists of liquid or solid particles in the air; it includes natural and man induced materials alike (smoke, pollens, dusts, chemical byproducts, lead

particles from auto exhausts, etc.). Some of these are highly toxic. Particulate matter contributes to a darkening of the atmosphere.

2. Gases: Numerous gases are produced by modern civilization, including carbon monoxide, sulfur oxides, hydrogen sulfide, fluoride, oxides of nitrogen, and gaseous organic compounds. These gases react with one another to produce haze and other visible products, cause damage to living plants and animals, and create unpleasant odors. They are emitted from both stationary sources and from automotive exhausts.
3. Photochemical Smog: This is a term given to the product of reactions between nitrogen dioxide and organic compounds in the atmosphere, which occur most often on warm, windless, sunny days — the sun causes the reaction between the organic compounds (hydrocarbons) and the NO_2 and forms smog, which includes the chemical Ozone. Other oxides of nitrogen can react with other compounds to form photochemical smog; these reactions depend on clear, sunny and warm conditions, which are common in the Bay Area during the summer. Sources for the reactive chemicals are auto exhausts and the burning of organic materials.

The preceding are the primary categories of air pollution. As with any process of this type, a complete discussion would involve volumes of material (additionally, much is yet to be learned about the problems) which cannot be included here; BAAPCD reports should be consulted for more information. Further comments can be made, however, on the sources of this pollution, its magnitude in the Fremont area and the means to combat it.

The District has identified the relative sources, in rounded figures, of particulates, organic materials, nitrogen and sulfur oxides and carbon monoxide. These are summarized in the table below:

¹Bay Area Air Pollution Control District, "Air Pollution and The San Francisco Bay Area," September 1972, pp.4--11.

Table 4

Percent Distribution of Pollutants by Source

<u>Source Category</u>	<u>Partic.</u>	<u>Organics</u>	<u>Nit. Ox.</u>	<u>Sulfur Ox.</u>	<u>Carbon Mox.</u>
Industrial	52%	25%	21%	85%	1%
Commercial	2%	14%	1%	1%	1%
Domestic	4%	1%	3%	1%	1%
Other	8%	2%	5%	8%	2%
Motor Vehicles (inc. aircraft)	34%	58%	70%	7%	96%
Total	100%	100%	100%	100%	100%
Tons per Day	160 tn.	1,500 tn.	720 tn.	210 tn.	5,000 tn.

Note: "Other" includes agricultural burning, equipment operation, ships and locomotives.

Source: BAAPCD, "Air Pollution and the San Francisco Bay Area," p. 37.

As the table indicates, the two major types of polluters in the Bay Area are industrial operations and motor vehicles. The former produce the vast majority of sulfur oxides and particulates, and the latter produces the greatest amounts of organic emissions (hydrocarbons) and nitrogen oxides, as well as nearly all the carbon monoxide. In terms of weight, organic materials and carbon monoxide are the most predominant.

Thus, much of the air pollution in the Bay Area, and in Fremont, can be related to industrial operations and vehicular emissions. The BAAPCD and the State and Federal Governments are involved in developing and enforcing air pollution control standards, including auto emission controls, which will lessen the pollution problem.

Recent trends indicate that air pollution is slowly being abated, in terms of accepted standards for pollution control. The BAAPCD has produced information to indicate that pollution levels

throughout the Bay Area are declining and that Fremont's levels are declining along with them. The extent of this reduction is indicated by the following figures, which are reproduced from the BAAPCD Special Report entitled "Comparison of Air Quality Data, 1969-1972." Three tables from this report are reprinted below, to provide data on Fremont in comparison with other locations in the Bay Area and to include the variety of indices used by the District:

Table 5

Station	SUSPENDED PARTICULATE MONITORING LEVELS 1969-1972							
	Annual Geom. Mean (ug/m ³)				% Days Over 100 ug/m ³ State Standard			
	1969	1970	1971	1972	1969	1970	1971	1972
San Francisco	51	51	47	46	5.3	5.9	2.0	1.6
San Rafael	48*	42	46	55	--	2.7	3.8	3.8
Richmond	57	56	44	41	15.4	8.2	0.6	5.5
Pittsburg	67	62	41	43	23.8	17.6	5.1	2.3
Fremont	73	71	58	56	26.2	25.7	11.2	7.6
Livermore	63*	63	70	67	--	14.4	15.5	16.8
San Jose**	60	61	77	66	18.7	18.8	25.3	17.4
Redwood City	53	54	32	44	16.4	7.9	1.9	4.5

* Calculated from incomplete data

** Station moved in 1970 and in 1972.

1 ug/m³ = .000001 grams
per cubic meter of air)

Note: Air Quality Standard

60 ug/m³ A.G.M.

100 ug/m³ 24-hour average

Source: Reprinted from BAAPCD, "Comparison of Air Quality Data, 1969-1972."

Table Five above shows a general improvement in the average particulate level over the last four years, for several communities in the area. Fremont, which had the highest 1969 level, experienced a decline, by 1972, to third highest. The number of days the State standard was exceeded followed the same pattern. In short, Fremont's air is not as laden with particulates as it used to be, but is still of relatively poor quality.

Table 6

SULFUR DIOXIDE MONITORING LEVELS, 1969-1972

(West-Gaeke 24-hour samples)

	<u>1969*</u>	<u>1970</u>	<u>1971</u>	<u>1972</u>
No. days <u>.04 ppm**</u>	12	2	1	2
% days <u>.04 ppm</u>	10.8	0.8	0.4	0.8
Average value by <u>Station</u>	<u>SO₂ (ppm)</u>			
San Francisco	.0087	.0035	.0048	.0037
San Rafael	.0046	.0021	.0016	.0020
Richmond	.0081	.0058	.0057	.0048
Pittsburg	.0144	.0061	.0056	.0020
Fremont	.0029	.0014	.0015	.0011
San Jose	.0026	.0015	.0007	.0010
Redwood City	.0014	.0008	.0007	.0002
Livermore	-	-	.0007	.0014
Burlingame	-	-	.0028	.0011
District Avg.	.0057	.0030	.0027	.0019

* Since 24-hour sampling began in June 1960, the 1969 average is June through December only.

** Ppm = Parts per Million, or .0001%

Source: BAAPCD, Op. Cit.

Table Six above shows trends for sulfur dioxide, the most common of the sulfur oxides, which comes primarily from the burning of fossil fuels in the Bay Area (vehicular emissions create relatively few sulfur oxides, according to Table Four presented earlier). The 4-year trend is generally favorable for most communities listed above, including Fremont. The application of stricter anti-pollution standards is felt by the BAAPCD to be a contributing factor in the overall decline of sulfur oxide air pollution. Nevertheless, as the figures show, the problem is still a significant one.

Table 7

ANNUAL OXIDANT EXPERIENCE BY STATION

1969-1972 (at .10, .15 and .20 ppm KI levels)

<u>Station</u>	<u>1969</u>			<u>1970</u>			<u>1971</u>			<u>1972</u>		
	.10	.15	.20	.10	.15	.20	.10	.15	.20	.10	.15	.20
San Francisco	0	0	0	6	1	1	2	2	0	0	0	0
San Rafael	16	0	0	22	5	2	9	2	0	5	1	0
Richmond	13	0	0	20	4	1	7	2	1	7	0	0
Pittsburg	28	3	0	34	6	1	23	4	1	25	4	0
Walnut Creek	54	21	5	34	8	3	36	8	1	30	3	0
Oakland	11	1	0	14	6	2	10	6	3	1	0	0
San Leandro	37	10	2	35	10	3	21	8	3	15	2	0
Fremont	74	33	9	43	19	8	45	14	6	44	14	6
Livermore	128	61	29	75	28	7	52	16	5	27	4	1
San Jose	71	15	3	56	12	0	14	1	0	19	3	1
Redwood City	39	9	3	17	5	0	17	4	1	17	3	2
Burlingame	14	1	0	15	6	3	5	1	0	8	0	0
Petaluma	-	-	-	-	-	-	6	0	0	0	0	0
Napa							9	0	0	20	2	0
Vallejo							11	2	0	15	7	1
Fairfield							12	1	0	4	0	0
Santa Rosa										2	0	0
Los Gatos										15	1	1
Mountain View										10	3	0
<u>District</u>	144	72	32	106	43	16	65	27	10	61	16	7

Source: BAAPCD, op. cit.

This table refers to the relative incidence of oxidants (those gases which form photochemical smog, or the product of photochemical processes) in the Bay Area at three different benchmark levels over a four-year period. The trend in Fremont has been downward, but by 1972 the City still registered the highest ppm densities of any checkpoint in the area. The oxidant levels can be seen during any warm, sunny day with moderate or no wind as a brown haze which hangs in the air, especially in the southern portions of the City. They are largely a product of vehicular emissions, and until emissions are brought under stricter control (such as the pending 1975 emission controls) the haze will likely remain. It should be remembered that much of this is generated outside of Fremont and brought in by moving air, but the City contributes its portion in emphasizing personal automotive transportation at the expense of local mass transit. A lowering of these oxidant levels is entirely possible, as the experience of other nearby communities as reported in Table Seven shows, but additional local, regional and state efforts will be required to accomplish this in Fremont.

As noted earlier, meteorological factors play an important role in air pollution trends, concentrations, etc. For example, the BAAPCD, in the report cited as the source for the tables, indicates that meteorological conditions accounted for much of the 1970-1971 improvement in oxidant levels throughout the District. The balance was probably due to emission controls, the District notes.

Specific data for Fremont is not available for other types of air pollutants as described earlier, but general information for other checkpoints around the Bay Area indicates that most pollutants are slowly being brought under control, or at least are not increasing in relative levels. Much of this is due to the growing enforcement actions of the Federal and State Governments in the case of automobiles and trucks, and of the BAAPCD and other agencies for other kinds of pollutants. This is not to say that the problems are all resolved, since continued population growth, industrial expansion, production and use of private automotive vehicles, and the like will shift the balance again unless the stricter control measures now being proposed by the Federal government are implemented.

Because of the complicated and only partially understood nature of air pollution, and its relationship to meteorological conditions (which are themselves not well understood), it is not possible here to outline all of the ramifications of poor air quality for the Bay Area in general or for Fremont in particular. Suffice it to say that the problem is everpresent, is highly visible, and that there are certain actions which can be taken to reduce its seriousness. Many of these actions must be taken on a State or regional scale — such as the activities of BAAPCD — since the problem is by definition a regional one, spilling over political boundaries. Others, however,

can be taken at a local level, with the objective being that each local government unit can contribute its share of effort in concert with the others, and produce favorable results on a regional scale. Part of the rationale for this is that only local governments have the power to take certain preventative actions — such as the limiting of private auto traffic on city streets or the preservation of non-polluting open lands — which are not available to higher-level governments. The City of Fremont is no exception to this and can begin to take certain overt actions to reduce air pollution hazards and thus contribute to an increase of air quality. Recommendations to this end follow:

1. The City should continue to support the efforts of local, regional, State and Federal agencies to combat air pollution problems and should work actively with BAAPCD in evaluating the effect of land use decisions on air quality.
2. Because of the direct correlation of the numbers of motor vehicles and air pollution (oxidant, carbon monoxide and nitrogen dioxide in particular), the City should begin considering ways of reducing dependence on private motor vehicles for transportation by its inhabitants. These actions, which can be studied and implemented through the planning process, can include the following:
 - a. Development of alternative local transit systems, such as bicycle facilities (lanes, storage lockers at public buildings, special trails) or bus facilities (private and/or public);
 - b. Reduction in the emphasis on broad, multi-laned thoroughfares and streets, which encourage private auto and truck travel and present hostile environments for bicycle or pedestrian travel;
 - c. Development of the City on a more vertical, rather than a totally horizontal scale, which would lessen the sprawling expansion (which generates greater needs for private transportation) of the City, and subsequently, produce a more compact community than is envisioned on the present, auto-oriented General Plan.
3. Reservation of large open space lands within the local airshed ("Airshed" is the atmospheric equivalent to watershed -- in short, a contained air basin) which will (1) not be developed and therefore not generate automotive and other pollutants and (2) contribute to the cleaning of the air through normal photosynthesis, is an action which should be taken in the near future.

4. The City should continue to support attempts to establish sound regional transit facilities, such as BART, which will provide alternatives to intercity vehicular transportation.

Because air pollution is a product of a long, complex chain of events, combating it must not only concern itself with eliminating the pollution itself or the direct source (such as placing emission controls on autos), but must also deal with the broader, more indirect sources. For example, a community development pattern which not only encourages private auto transportation but necessitates it because there is no practical alternative is a direct contributor to air pollution. A comparison can be drawn between the compact community where citizens can move about on foot, bike or bus and the broad, sprawling community which renders these alternatives impractical or useless for everyday life even if they are available. Fremont appears to be among the latter; this is pointed out because the City is still at a point where a fundamental change can be made in its development pattern — one which emphasizes little or no horizontal growth and seeks instead a “filling-in” or vertical growth — which could contribute in large part to making non-vehicular modes of transit not only acceptable but superior to vehicular modes. Obviously, such a change in direction requires considerable study and debate and pollution considerations are not the only ones which relate to it, but the issue is one which is becoming increasingly important and relevant, as the numerous costs of continued sprawl take their toll. For this reason, the question of City development patterns as they impact on air quality and other factors making up the quality of life, must be taken up by local officials, and some new directions proposed which contribute to a solution of regional problems such as air pollution. Other chapters of the Conservation Element contain recommendations to this end; the total package should be considered and new proposals distilled from it.

WASTE DISPOSAL

The disposal of wastes generated by an urban society generally has strong implications for the preservation of resources. Solid waste must be placed in suitable locations on the land, and liquid wastes are generally disposed of, ultimately, in the water. In each case, people are affected, and the resource base is required to absorb the brunt of disposal activities. This chapter will briefly investigate waste disposal activity in the Fremont area, and will provide recommendations about future City policies toward the treatment of wastes.

Solid Waste

Solid waste disposal services are provided to the City, under franchise, by the Oakland Scavenger Company through a local agency, The East Bay Disposal Company. A regular collection schedule is followed, for which clients are billed, and individual transport of rubbish to the disposal site is also permitted. All wastes except industrial process and cannery wastes are accepted.

Disposal activities take place on a 260-acre site located at the western extremity of Durham Road. The site operates under a City use permit which allows disposal activity under carefully regulated conditions. Two major conditions are that solid waste comes to the site from only the Tri-Cities area, and that Oakland Scavenger Company operate the site for only so long as the company's franchise is approved by the City. The current franchise expires in 1981; the site itself has an anticipated life span of about 25 years.

One of the major considerations in connection with solid waste is the future volume of material to be disposed of, and appropriate use of the sites after they have been filled to capacity. The disposal company, in its 1973 report¹ estimates that it serves a population of about 181,600 in the Tri-Cities area. About 30 pounds of waste per week per capita are generated by this population; about half of this is mixed garbage (including organic wastes) and half is rubbish (household goods, etc.) from residential, commercial and industrial sources. The company forecasts future quantities of about 140,600 tons per year from the Tri-Cities area, which equates to about 182 acre-feet per year of waste on the landfill site each year. There is ample evidence to indicate that the amount of solid waste being generated each year by modern society is increasing, as disposable products become more common, and the above figures may increase in the near future. The ever-growing population of the Tri-Cities area and of the county will add to the burden. Because the current disposal site has a finite life span, other disposal sites will have to be found.

In 1972, the Alameda County Planning Commission was charged with the task of coordinating a county-wide solid waste management plan, in accordance with State law requiring such planning.

The project is being funded in part by EPA. A technical advisory committee composed of representatives of the county, cities within the county, industry representatives and public agency representatives has been formed and is meeting on a regular basis. The committee has the task of preparing the plan, holding public hearings, etc. Ultimately, a comprehensive plan for solid waste management will emerge, which is intended to meet disposal needs of the entire county for the foreseeable future. The City of Fremont is represented on this committee.

At this point, no precise plans have been prepared about the subject, although suggestions have been made about possible sites around the county. Fremont restricts operation of its disposal site to the local area, and it appears unlikely that it would be made available to the larger area of the county; however, the study may eventually result in recommended sites near or perhaps within the City. The plan will have to balance the needs of the county against the wishes of each local area within it (solid waste disposal sites are not popular additions to a community, but are necessary to the functioning of urban civilization), and will provide measuring tools, criteria, etc., to accomplish this.

The plan will also address the matter of site use upon completion of disposal operations. In Fremont's case, no specific plans have yet been prepared for the Durham Road site, although the General Plan indicates that the land should be used for a commercial recreational activity, such as a City golf course, or as industrial land of a type compatible with the location. Uses of this type are generally suitable for disposal sites, and in view of the proximity of the Bay and the wildlife refuge, some recreational uses could be highly suitable in this specific instance.

The City should participate fully in the deliberations of the technical planning group which is preparing the county-wide plan, and should support that plan once it is completed. Because of the large degree of population growth anticipated by the City, planning studies toward future disposal sites within the City should also go on, at least as a contingency to the county effort.

This type of local study should be done well in advance of the closing date of current operations at the Durham Road site. Several alternative methods of waste disposal, including landfill, should be considered, and the results integrated with the county plan if appropriate.

Liquid Waste

Liquid waste, or sewage, is collected and treated by the Union Sanitary District which serves the Tri-Cities area. The District has about 469 miles of main sewers, which are sized to serve a population of about 450,000 people. The District operates three treatment plants - the Newark

FOOTNOTES:

1. Oakland Scavenger Co., "Estimate of Solid Wastes Generated in Alameda County, 1973," 1973 (preliminary report).
2. Union Sanitary District, "Report on Sanitary Sewer Service," January 1973.
3. East Bay Dischargers, *Water Quality Management Program*, Synopsis, April 1972.

ENVIRONMENTAL CONSTRAINTS

The preceding pages of this report have described environmental conditions throughout Fremont, and have identified particular concerns or problems that may affect future land use or overall development of the City. Several recommendations regarding these problems have been made, and some of these relate directly to specific land areas within the City.

Both problems and recommendations can be embodied in an environmental constraints map, which illustrates graphically - in a generalized, City-wide sense - the location and extent of the implications of them for the City. The map will also facilitate discussion and adoption of the Conservation Element, since local decision makers will be able to directly see the products of environmental planning. Other types of concerns, of course (such as policy attitudes toward inter-agency planning), cannot be graphically illustrated; the constraints map should, therefore, be considered only a partial listing of Conservation Elements outputs.

The constraints map is a judgemental one, which draws lines between various degrees of conditions: for example, a 29% slope is not considered a severe constraint while a 30% slope is. While such divisions are artificial, they do lend themselves to the formulation of specific City policy toward land use, and at the least provide some starting point for further analysis. By its nature, the constraints map does not contain "gray areas"; it is a yes-no proposition - either a given area will support development or it will not. This characteristic makes the map a useful one in its simplicity, and also forces a careful consideration of the components that make it up.

In Fremont's case, the components are as follows:

1. All lands with a soil capability classification of VII or VIII;
2. All lands having natural slopes in excess of 29%;
3. Earthquake fault and fault trace corridors, and known areas of existing or potential landslide hazard;
4. All major flood control facilities, including Alameda Creek, temporary ponding areas, and permanent flood control ponds (such as Lake Elizabeth);
5. Identified ground water recharge areas - primarily the recharge pits in the Niles District and along Alameda Creek;
6. All natural stream corridors in the hill areas (Mill Creek, etc.);
7. All lands below elevation 10 feet Mean Sea Level;
8. Existing quarry sites (until complete rehabilitation occurs);
9. The National Wildlife Refuge, which encompasses unbuildable lands;
10. All areas of significant rare or endangered plant or animal habitat, and all natural woodland areas in the City (Particularly in the hill areas).

The totality of these constraints is shown on Map Eight. Each of the components may be examined by reference to maps presented throughout the preceding pages of this report. They can be adjusted to reflect different judgments toward environmental conditions or new information about such conditions, but at the present time represent the best available information on the subject matter.

Use of the constraints map should be along the lines of policy formulation. Areas which are experiencing constraints may support development, but only after complete study to ensure that the suspected problems do not in fact exist. This map and others in the Conservation Element will also be used to generate information for open space designations in the following Open Space Element.

FREMONT GENERAL PLAN CONSERVATION ELEMENT

ENVIRONMENTAL CONSTRAINTS

LEGEND

 ENVIRONMENTAL ISSUE AREA
(EXCLUDES SEISMIC INFORMATION)

 CITY OF NEWARK

 FREMONT CITY BOUNDARY



MAP 8

THIS MAP IS ONE OF SEVERAL WHICH ACCOMPANY THE TEXTUAL MATERIALS OF THE CONSERVATION ELEMENT IN THE FREMONT GENERAL PLAN. IT IS INTENDED TO ILLUSTRATE THE CONCEPTS AND PROPOSALS OF THE ELEMENT, AND SHOULD BE USED FOR GENERAL PLANNING PURPOSES ONLY. PRECISE PLANNING DATA MUST BE USED TO SUPPLEMENT THIS INFORMATION AT THE TIME OF PLAN IMPLEMENTATION.

DESCRIPTION OF GEOLOGIC MAP UNITS

DEPARTMENT OF THE INTERIOR
UNITED STATES GEOLOGICAL SURVEY
BASIC DATA CONTRIBUTION
NUMBER EIGHT

DESCRIPTION OF MAP UNITS

1 MUD

Mud deposited during the past 10,000 years in San Francisco Bay and in marshlands surrounding San Francisco Bay and the delta area of the Sacramento-San Joaquin Rivers. Location of landward border approximate. In places covered with man-made fill. Mud is mostly clay- and silt-size particles, but locally contains up to 15 per cent medium- to fine-grained sand. Contains layers of sand and gravel 1/8 inch to 5 feet thick, especially common near mouths of streams. Thickness of mud generally varies from about 5 feet at landward edge to about 60 feet at bay edge; maximum thickness offshore about 140 feet. Where used for foundation purposes mud may subside, settle differentially, fail by shearing, shrink and crack when dried, and expand and become weak and plastic when wet. Amplitude, duration and period of earthquake shaking is greater in this map unit than in firm soil or rocks. Such shaking may cause liquefaction of sand layers in the mud and give rise to lurching, subsidence and landsliding. It is necessary to pay special attention to the design of highrise structures on this unit because their natural period of vibration can or may be similar to the natural period of earthquake vibrations in the thick soft mud. Top to 2 to 4 feet in diked-off, drained areas becomes dessicated and stronger than underlying mud.

2 UNCONSOLIDATED SEDIMENTS

Unconsolidated sediments--gravel, sand, silt, clay and peat that underlie broad valleys and other flatlands; include deposits of marine beaches and adjoining dunes, alluvial plains, terraces, fans, river flood plains, channels, levees, mudflows and lake bottoms. Thickness is more than 1,000 feet in Santa Clara Valley near San Jose, in Livermore Valley, and in the Great Valley; 500 to 1,000 feet in Santa Rosa - Cotati - Petaluma Valley and in Sonoma and Napa Valleys; a few feet to about 600 feet underlying and landward of unconsolidated mud east and west of San Francisco Bay; a few feet to about 300 feet in the modern and raised beach and dune deposits along the Pacific Coast. Sand and gravel are generally excellent for fill, road metal and concrete and bituminous aggregate. Principal source of concrete aggregate and sand for the map area is in the Livermore Valley where deposits are several hundred feet thick. Engineering properties vary with sediment type and water content. Silt and clay deposits may subside, settle differentially, fail by shearing, shrink and crack when dry, and expand and become plastic and weak when wet. During strong earthquakes, shaking may be severe where deposits are more than several hundred feet thick and the water table is near the surface. 0 to 10,000 years (Holocene) to as great as about 5 million years old (Pliocene).

In San Francisco, include beach and dune sand of Holocene age (past 10,000 years) and older marine sand and clayey sand and silt of late Quaternary age (Colma Formation - approximate range 10,000 to 500,000 years). Thickness ranges from a few feet to 300 feet.

3 MODERATELY CONSOLIDATED TO WELL-CONSOLIDATED SEDIMENTARY ROCKS

Sandstone, shale, siltstone, conglomerate, chert, porcellanite, coal, limestone, agglomerate and tuff, moderately to well-consolidated. Total thickness approximately 20,000 feet, local thickness generally more than 100 feet. Map unit includes a wide variety of rocks with a wide range of physical characteristics and uses. Rocks older than Pliocene are generally well compacted, have a high bearing capacity, and make fair to good fill. Shale and claystone and poorly cemented sandstone may slump badly on slopes steeper than about 2 to 1. Some contain bentonitic beds that swell greatly and become plastic and weak when wet and shrink and crack severely when dry. Shearing and chemical alteration not as common as in Franciscan assemblage. Some beds are or have been commercial sources of coal, foundry, refractory, and glass sand, ceramic and fire clay, diatomite, natural gas (leading producers in the State), and oil. Beds may be future sources of bentonite, pozzolan and expansible shale for lightweight concrete. Age ranges from about 5 to 55 million years (early Pliocene to Eocene).

4 VOLCANIC ROCKS

Volcanic rocks and minor interbedded gravels, sands and clays. Unit includes lava flows and associated dikes and pyroclastics (volcanic fragments ejected from a vent) of basalt, andesite and rhyolite composition. Maximum thickness approximately 3,000 feet. Generally fresh rock of high strength and hardness, consequently is important source of concrete aggregate, fill, riprap and flagstone, and makes good foundations. Interbedded sediments and rhyolitic pyroclastics may contain clay and present foundation problems. Age ranges from about 3 to 40 million years (Pliocene to Oligocene).

5 FRANCISCAN ASSEMBLAGE

Franciscan assemblage. A complex of sedimentary, volcanic and metamorphic rocks 70 to 80 million years old (Jurassic to Cretaceous). The basement (oldest) rock in the area east of the San Andreas fault, and on San Francisco Peninsula east of the Pilarcitos fault.

KJf, mostly graywacke-type sandstone and shale; interbedded with small amounts of conglomerate, radiolarian chert and limestone; includes small amount of metamorphic rock. Sandstone and shale is firm rock where fresh, but generally highly fractured. In places weathered to depth of 60 feet. Weathered shale may contain large amounts of swelling clay; weathered sandstone also contains swelling clay. Source of good quality fill; riprap more than 2 feet in diameter is scarce. Fresh rock may require blasting to excavate. Crushed rock generally unsatisfactory for concrete aggregate because of presence of shale and chemically altered rock, but stream gravel derived from Franciscan assemblage makes good quality concrete aggregate and is the main source in the San Francisco Bay area. Expansible shale is made by heating the shale at several plants in the area.

Radiolarian chert is generally firm, somewhat brittle, well-bedded rock with little or no soil. Beds are 1 to 4 inches thick and alternate with shale beds generally 1/4 inch thick. Source of good quality fill. Altered to clay along faults. Chert sections are generally sparse and occur in lenses less than 100 feet thick; however, they are thicker and especially abundant in the Sunset Heights and Mt. Sutro areas of San Francisco, in southern Marin Peninsula, in the hills of San Mateo, Belmont and San Carlos, and in northeastern Santa Clara County and adjoining parts of Alameda County. Small deposits of manganese may occur in chert. Manganese ore has been mined in Santa Clara, Alameda, Sonoma and Napa Counties.

Metamorphic rocks are widely scattered and occur within the other Franciscan rocks generally as isolated rounded masses up to 100 feet in diameter or in larger, tabular or irregular shaped bodies. Metamorphic rocks are generally tough and sparsely fractured. Excellent source of fill and riprap where sufficiently abundant.

Limestone occurs on San Francisco Peninsula as isolated deposits or as small lenses. It is a firm rock that is good for fill and is raw material for cement. A large deposit in Santa Clara County supplies one of the largest cement plants in the world.

Zones of intensely sheared rock are common in the Franciscan assemblage. They appear to be more or less tabular, a few inches to several hundred feet in thickness, extend over many square miles, and are generally, but not everywhere, nearly flat-lying or gently dipping. The zones (melange) consists of a soft, clayey, highly sheared matrix containing minor hard spheroidal rock masses, rounded by shearing. The hard rock pieces are of all sizes up to hundreds of feet but are generally less than 20 feet in diameter and include sandstone, volcanic rock, radiolarian chert, metamorphic rock, limestone and ultramafic rocks. The matrix is generally shale altered to swelling clay containing large amounts of chlorite and montmorillonite. The matrix is weak and plastic when wet and strongly influences the physical properties of the entire mass. Consequently, landsliding is common on slopes of this material and the erratic distribution of hard, coherent rock masses within the shear zones give rise to considerable local variation in physical characteristics and may lead to erroneous appraisal of foundation conditions unless the nature of the shear zones is understood.

KJv, volcanic rocks, mostly basaltic and spilitic pillow lavas and pyroclastics (fragmental material ejected from a volcanic vent). Pillows are roughly ellipsoidal or spheroidal, 6 inches to 4 feet in maximum dimension, and are separate by 1 to 12 inches of pyroclastic material. Where fresh the pillows are hard but the surrounding matrix is generally softer. The pillows and enclosing material both weather to a swelling clay, thus are crumbly and friable when dry and plastic and weak when wet. Pyroclastic materials, in beds as much as 100 feet thick, are interbedded with pillow lavas. They generally are not as coherent as pillow lava. The weathered mantle on Franciscan volcanic rock may reach a thickness of 60 feet, and commonly is the locale of numerous small landslides.

6 SANDSTONE, SHALE AND CONGLOMERATE

Mostly graywacke sandstone, shale and conglomerate; unit includes a few thin limestone beds, and locally in lowest, oldest part basaltic pillow lavas and agglomerates, and chert. Of same age and with approximately the same physical properties as Franciscan assemblage, but differs in the absence of small-scale pervasive crumpling, fracturing and shearing (though shear zones do occur in these rocks), the greater persistence of individual beds and the occurrence of broad open folds. In many places this unit overlies the Franciscan assemblage but is separated from it by a zone of strongly sheared rock. As in the Franciscan assemblage, weathered shales contain large amounts of swelling clays. Source of good quality fill, riprap and impervious zone material for earth dams. Fresh rock may require blasting to excavate. Shales can be used to make expansible, lightweight aggregate. Great Valley sequence, 70 to 180 million years old (Jurassic to Cretaceous).

7 SERPENTINE AND PERIDOTITE

Ultramafic rocks, mostly serpentine derived from peridotite, rarely peridotite. Serpentine bodies consist of firm to moderately firm rounded pieces encased in a soft, waxy, weak matrix of thoroughly sheared and partly altered serpentine. Serpentine also contains sparse inclusions up

to 40 feet in size of hard calcsilicate and other metamorphic rocks and fresh and hard to altered crumbly gabbro and diabase. The volume proportion of hard and moderately hard peices of serpentine and other rocks to soft matrix varies considerably, but averages about 3:1. In places the serpentine is almost entirely sheared for horizontal distances of as much as 100 feet; in rare places the serpentine is moderately firm and contains less than 10 per cent soft material. Some serpentine border zones consist of severely sheared and altered rock that may be more than 100 feet wide and consist of large amounts of highly swelling clay. Some serpentine is altered to silica-carbonate rock, which is exceedingly hard, dense to spongy, rusty-weathering rock. Excavation of this rock may require blasting. A variety of commercial mineral commodities occur within or at the borders of serpentine bodies. They include mercury, short-fiber asbestos, magnesite and chromite.

Peridotite bodies are rare. The main bodies in the area are The Cedars ridge about four miles north of Cazadero, Sonoma County and Red Mountain in Santa Clara County. They are largely unserpentinized olivine-rich rock and are usually harder and less sheared than the more thoroughly serpentinized rock.

6 GRANITIC ROCKS

Granitic rocks. Mostly coarse grained, crudely foliated biotite-hornblende quartz diorite and granodiorite. In a few places includes small bodies of marble, biotite schist, amphibolite and quartzite up to 100 feet in greatest dimension. Granitic rocks occur only west of the San Andreas fault in Marin and Sonoma Counties and west of the Pilarcitos fault in San Mateo County. They probably extend in depth thousands of feet. Locally severely fractured, sheared and altered to clay. Pervasively altered, but only to a minor or moderate degree; where freshest, they are firm to moderately firm rock and make good foundations and good fill and small size riprap (less than 2 feet in diameter), but they are not fresh enough for use as aggregate for concrete. Weathering, generally to a coarse clayey sand, is common to depths of 10 feet, and in places to as much as 70 feet. Approximately 80 to 90 million years old.

APPENDIX B

PLANT AND ANIMAL LIFE LISTINGS

Vegetation

Three major categories of plant life can be found in Fremont: Marsh, grass and forbs and cultivated and pasture types. The marsh type consists of fresh water and salt water (brackish) plant associations. The grass and forb cover type is characterized by a wide variety of annual grass species and annual plants. Cultivated and pasture cover types are characterized by agricultural plants such as table crops, particularly cabbage and cauliflower and some fruit orchards. Pasture area is common and is dominated by grasses and clover (*Trifolira* spp.). While there is no official list of endangered plants, Table B-1 lists some commonly known to be rare or endangered. The official state flower, the California Poppy, can also be added to this list.

**Table B-1: Rare, Endangered and Possibly Extinct
Plants Whose Range Includes the City
of Fremont**

<u>Scientific Name</u>	<u>Common Name</u>	<u>Local Habitat</u>	<u>Cover Type</u>
<i>Amsinckia grandiflora</i>	A fiddleneck	Open grassy slopes below 1200 feet, inner coast range	Grass and forbs
<i>Balsamorhiza macrolepis</i>	A sunflower	Fields and rocky hillsides below 2000 feet interior slopes near San Francisco Bay	Grass and woodlands
<i>Helianthella castanea</i>	A sunflower	Grassy hillsides 500-4000 feet San Francisco Bay region	Grass and woodlands
<i>Tropidocarpum capparideum</i>	A mustard	Alkaline low hills below 500 feet in region around foot of Mt. Diablo	Grass

Source: Jones & Stokes Associates, Inc., *Draft Environmental Impact Report on the Alameda County Water District Major Facilities Improvement Program, 1973.*

x = Seen in Central Park
o = Seen at various parts of Fremont

Table B-2: Fremont's Bird Check List
Source: Audubon Society, Ohlone Chapter

GREBE			Duck		
Red-Necked	o		Red Head	o	
Horned	o	x	Ring-Necked	o	
Eared	o	x	Canvas Back	o	x
Western	o	x	Harlequin		
Pied-Billed	o	x	Ruddy Duck	o	x
PETREL			TEAL		
Ashey	o		Green Winged	o	x
			Cinnamon	o	x
PELICAN			WIDGEON		
White	o	x	American	o	
Brown	o		Shoveler	o	x
CORMORANT			SCAUP		
Double-Cr.	o	x	Greater	o	x
Brandt's	o		Lesser	o	
HERON			GOLDEN EYE		
Great Blue	o	x	Common	o	x
Green	o	x	Bufflehead	o	x
Bl.-Cr. Night	o				
EGRET			SCOTER		
Common	o	x	White-Winged	o	
Snowy	o	x	Surf	o	
BITTERN			MERGANSER		
American	o	x	Hooded	o	
FLAMINGO			VULTURE		
American	o		Turkey	o	x
SWAN			CONDOR		
Whistling	o	x	California	o	x
GOOSE			KITE		
Canada	o	x	White-Tailed	o	x
White Fronted	o				
Snow	o		HAWK		
Ross	o		Sharped-Shinned	o	x
			Red-Tailed	o	x
DUCK			Red-Shouldered	o	
Fulvous Tree	o		Rough-Legged	o	
Mallard	o	x	Ferruginous	o	
Gadwall	o	x			
Pintail	o	x	SWIFT		
Wood Duck	o		Vaux's	o	

x = Seen in Central Park
o = Seen at various parts of Fremont

SWIFT

White-Throated o x

EAGLE

Golden o x

HAWK

Marsh o x

Pigeon o x

Sparrow o x

FALCON

Peregrine o

QUAIL

California o x

PHEASANT

Ringed-Neck o x

Chukar o

RAIL

Clapper o

Virginia o x

Sora o x

GALLINULE

Common o x

COOT

American o x

PLOVER

Semi-Palmated o

Snowy o

Killdeer o x

Black Bellied o

TURNSTONE

Ruddy o

Black o

SNIFE

Common o x

CURLEW

Long-Billed o

TATTLER

Willet o x

YELLOWLEGS

Greater o x

YELLOWLEGS

Knot o

Dunlin o x

DOWITCHER

Short-Billed o

Long-Billed o x

SANDPIPER

Western o x

GODWIT

Marbled o

AVOCET

American o

STILT

Black-Necked o

PHALAROPE

Wilson's o

Northern o

GULL

Glaucous-Winged o

Western o

Herring o x

California o x

Ring-Billed o x

Mew o

Bonaparte's o x

Franklin's o x

KITTIWAKE

Black-Legged o x

TERN

Forster's o x

Least o

Caspian o x

PIGEON

Band-Tailed o

DOVE

Rock o

Mourning o x

OWL

Barn o

Screech o

Great Horned o x

x = Seen in Central Park
 0 = Seen at various parts of Fremont

OWL

Pygmy	o	
Burrowing	o	x
Short-Eared	o	
Saw-Whet	o	

HUMMINGBIRD

Anna's	o	x
Rufous	o	x
Allen's	o	x

KINGFISHER

Belted	o	x
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FLICKER

Yellow-Shafted	o	
Red-Shafted	o	x

WOODPECKER

Acorn	o	x
Lewis	o	

SAPSUCKER

Yellow-Bellied	o	x
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WOODPECKER

Downy	o	
Hairy	o	
Nuttall's	o	

KINGBIRD

Western	o	
---------	---	--

FLYCATCHER

Ash Throated	o	x
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PHOEBE

Black	o	x
Say's	o	

FLYCATCHER

Western	o	x
Olive-Sided	o	

LARK

Horned	o	
--------	---	--

SWALLOW

Violet Green	o	x
Tree	o	
Bank	o	

SWALLOW

Rough-Winged	o	
Barn	o	x
Cliff	o	x

JAY

Steller's	o	
Scrub	o	x

MAGPIE

Yellow-Billed	o	x
---------------	---	---

CROW

Common	o	x
--------	---	---

CHICKADEE

Chestnut Backed	o	x
-----------------	---	---

TITMOUSE

Plain	o	x
-------	---	---

BUSHTIT

Common	o	x
--------	---	---

NUTTHATCH

White Breasted	o	x
Red Breasted	o	x
Wrentit	o	x
Dipper	o	

WREN

Wintek	o	
Bewick's	o	
Long Billed Marsh	o	x
Mockingbird	o	x
Thrasher	o	
Robin	o	x
Thrush, Varied	o	x
Hermit	o	

BLUE BIRD

Western	o	x
Mountain	o	
Gnatcatcher Blue		
Gray	o	x
Kinglet Golden-Crowned	o	
Ruby Crowned	o	x
Pipit, Water	o	x
Waxwing, Cedar	o	x
Shrike, Loggerhead	o	x

x = Seen in Central Park
o = Seen at various parts of Fremont

BLUE BIRD

Starling	o	x
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VIRED

Hutton's	o	x
Warbling	o	

WARBLER

Orange-Crowned	o	x
Yellow	o	
Myrtle	o	x
Audubon	o	x
Black Throat Gray	o	x
Townsend's	o	x
Yellow Throated	o	x
House Sparrow	o	x
Meadow Lark Western	o	x
Oriole, Bullock's	o	x
Blackbird, Brewer's	o	x

BLACKBIRD

Redwinger	o	x
Tri-Colored	o	x
Cowbird Brown-Headed	o	x

TANAGER

Western	o	
Summer	o	
Grosbeak Black-Headed	o	
Finch-Purpl	x	
House	o	x
Siskin, Pine	o	x

GOLD FINCH

American	o	x
Lesser	o	x

TOWHEE

Rufous-Sided	o	x
Brown	o	x

SPARROW

Savannah	o	x
Lark	o	

JUNEO

Slate-Colorer	o	
Oregon	o	x

SPARROW

White Crowned	o	x
Golden Crowned	o	x
White Throated	o	
Fox	o	x
Lincoln	o	x
Song	o	x
Sharp Tailed	o	
Egret, Cattle	o	

Table B-3: Rare and Endangered Animals Whose Range Includes Alameda County

<u>Common Name</u>	<u>Scientific Name</u>	<u>FR</u>	<u>Status BSF & W</u>	<u>CAL</u>
BIRDS				
California brown pelican	Pelecanus occidentalis californicus	E	U	E
Wood ibis	Mycteria americana		P	
Aleutian Canada goose	Branta canadensis leucopareia	E	E	
Tule white-fronted goose	Anser albifrons gambelli		E	
Red-bellied red-shouldered hawk	Buteo lineatus elegans		U	
Ferruginous hawk	Buteo regalis		U	
Southern bald eagle	Haliaeetus leucocephalus leucocephalus	E	E	E
American osprey	Pandion haliaetus carolinensis		U	
Prairie falcon	Falco mexicanus	R		
American peregrine	Falco peregrinus anatum	E	E	E
Greater sandhill crane	Grus canadensis tabida		R	
California clapper rail	Rallus longirostris tabida	E	R	E
California black rail	Laterallus jamaicensis coturniculus		R	R
California least tern	Sterna albifrons browni	E	E	E
MAMMALS				
Salt marsh harvest mouse	Reithrodontomys raviventris	E	U	E

FR Federal Register, Vol. 35, Number 199. October 13, 1970

BSF&W Bureau of Sport Fisheries and Wildlife. *Rare and Endangered Fish and Wildlife of the United States*. 1968.

CAL California Department of Fish and Game. *At the Crossroads. A Report on California's Endangered and Rare Fish and Wildlife*. 1972.

E Endangered

R Rare

P Peripheral

U Status uncertain

<u>Species</u>	<u>Salt Ponds</u>	<u>Tidal Flats</u>	<u>Open Water</u>	<u>Salt Marsh</u>	<u>Grassland</u>	<u>Fresh Water Marsh</u>	<u>Dikes and Levees</u>
California vole				x	x	x	x
Norway rat					x		
Black rat					x		
House mouse					x		
Black-tailed jackrabbit					x		
Brush rabbit					x		
Black-tail deer					x		

Source: Jones & Stokes Associates, Inc., Background Document to *Draft Environmental Impact Report on the Alameda County Water District Major Facilities Improvement Program*



Walt Luke

DESCRIPTION: A unique mouse inhabiting San Francisco Bay brackish and salt marshes. Recognized by its rich brown back and cinnamon to whitish underparts. One of few mammals able to drink salt water.

DISTRIBUTION: Formerly inhabited the extensive marshes once bordering San Francisco Bay. Now restricted to scattered colonies within its original range.

STATUS: Endangered. Continual destruction of salt marsh habitat by bay fill and diking are major factors contributing to decline of the salt marsh harvest mouse.

PROTECTIVE MEASURES TAKEN:

- ... Fully protected mammal under state law.
- ... Acquisition of Tubbs Island, North San Francisco Bay, and Knapp Gun Club, South San Francisco Bay, by The Nature Conservancy.
- ... Preservation of Palo Alto Marsh by City of Palo Alto.
- ... Portions of Grecko Island and Mowry Slough, South San Francisco Bay, established as an Audubon Society sanctuary.
- ... Moratorium on bay fill set by Bay Conservation Development Commission.

SALT MARSH HARVEST MOUSE

RECOMMENDATIONS:

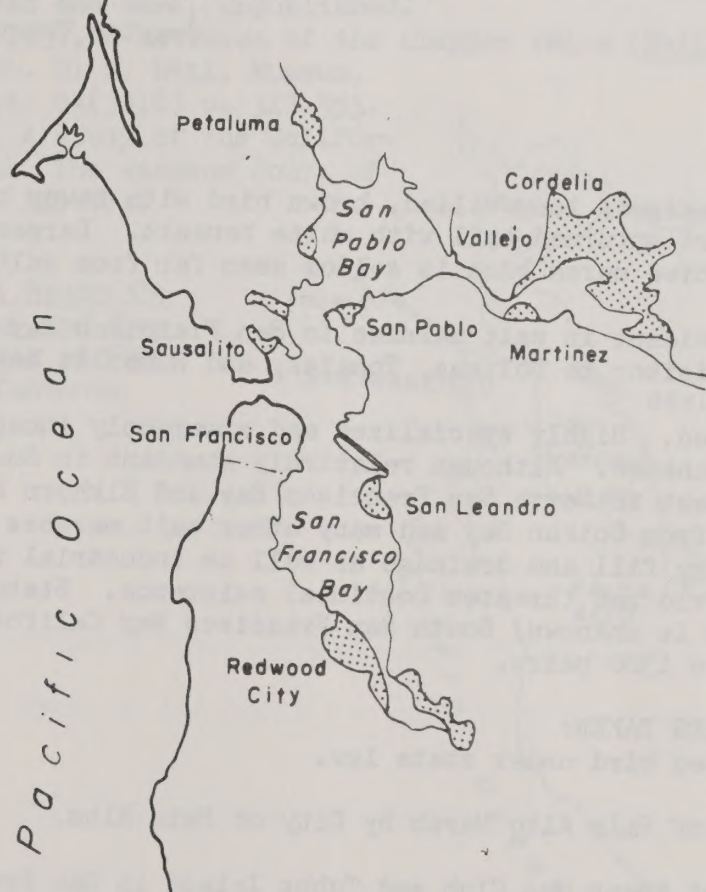
- ... Establish South San Francisco Bay National Wildlife Refuge.
- ... Preserve habitat areas critical to salt-marsh harvest mouse survival through acquisition, easement, or memorandum of understanding with landowners.

REFERENCES:

- Fisler, G. F. 1965. Adaptations and specification in harvest mice of the marshes of San Francisco Bay. Univ. of Calif. Publ. in Zool. 77. 108 p.
- Schaub, D. B. 1971. Salt marsh harvest mouse survey, 1971. Calif. Dept. of Fish and Game, P-R Completion Rept. W-54-R-3. 35 p.

SOURCE:

At the Crossroads, A Report On California's Endangered And Rare Fish and Wildlife, Dept. of Fish and Game, State of California, Jan. 1972





Crayton Thorup

DESCRIPTION: Hen-sized, long-billed, brown bird with tawny breast, barred flanks, and a short upturned tail with white beneath. Largest of California's rails, this secretive marsh bird is seldom seen far from salt marshes.

DISTRIBUTION: Resident in salt marshes in San Francisco Bay and Elkhorn Slough. Casual visitor to Bolinas, Tomales, and Humboldt bays.

STATUS: Endangered. Highly specialized and apparently incapable of adapting to environmental change. Although relatively abundant in South San Francisco Bay, only a few nest in North San Francisco Bay and Elkhorn Slough. Clapper rails are absent from Suisun Bay and many other salt marshes along north and central coast. Bay fill and drainage as well as industrial pollution and the introduced old-world rat threaten continual existence. Status of the Elkhorn Slough population is unknown; South San Francisco Bay California clapper rail population numbers 1300 pairs.

PROTECTIVE MEASURES TAKEN:

- ... Fully protected bird under state law.
- ... Preservation of Palo Alto Marsh by City of Palo Alto.
- ... Acquisition of Knapp Gun Club and Tubbs Island in San Francisco Bay by the Nature Conservancy.
- ... Portions of Grecko Island and Mowry Slough, South San Francisco Bay, established as an Audubon Society sanctuary.
- ... Moratorium on bay fill set by Bay Conservation Development Commission.

CALIFORNIA CLAPPER RAIL

RECOMMENDATIONS:

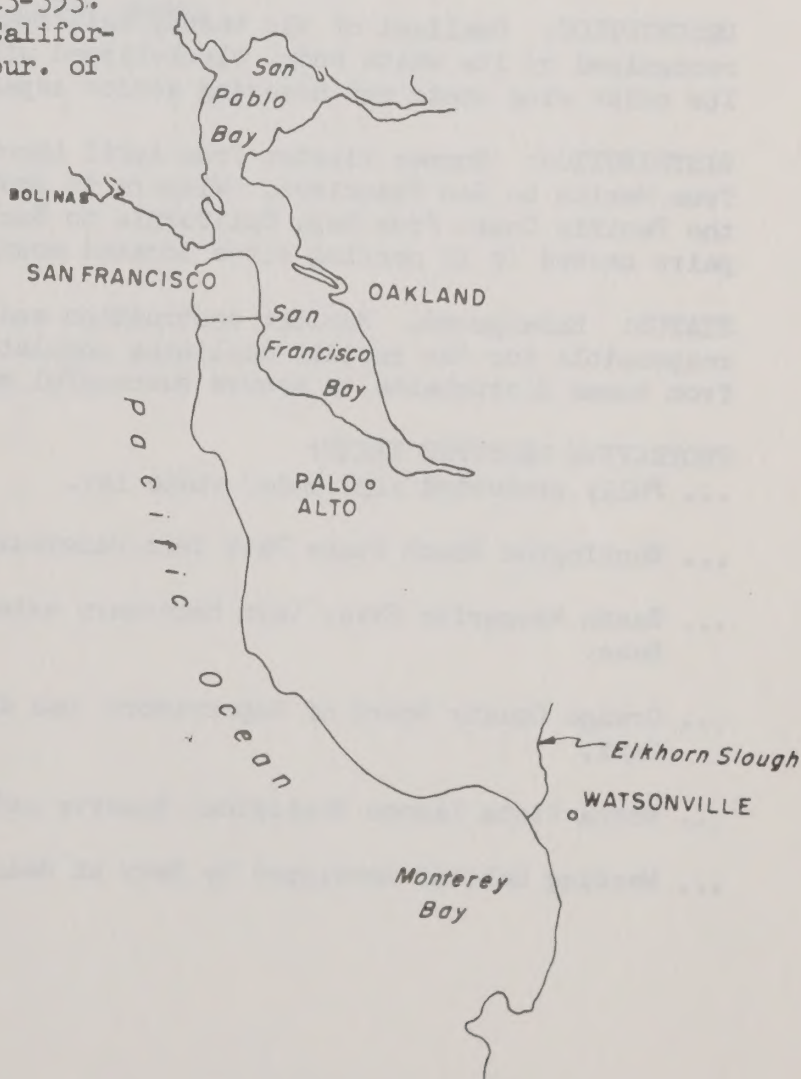
- ... Protect salt marsh areas in South San Francisco Bay critical to clapper rail survival through immediate acquisition, easement, or memorandum of understanding with landowners.
- ... Establish South San Francisco Bay National Wildlife Refuge.
- ... Initiate an animal control program to reduce nest predation by old world rats.
- ... Instigate a program to establish breeding colonies in areas presently not occupied by the California clapper rail.

REFERENCES:

- Gill, R. E. 1971. Breeding bird survey South San Francisco Bay, 1971. Calif. Dept. Fish and Game, unpublished.
- Oberholser, H. C. 1937. A revision of the clapper rails (Rallus longirostris broddaert). Proc. U. S. Natl. Museum, Smithsonian Inst. 84(3018) p. 313-353.
- Zucca, J. J. 1954. A study of the California clapper rail. The Wasmann Jour. of Biol. 12 (2) p. 135-153.

SOURCE:

At The Crossroads. A Report On California's Endangered And Rare Fish And Wildlife. Dept. of Fish and Game, State of California, January, 1972





Kenneth Fink

DESCRIPTION: Smallest of the terns, this sparrow-sized bird is easily recognized by its white body, black-tipped wings, and black-capped head. Its quick wing beats and hovering action separate it from the larger terns.

DISTRIBUTION: Summer visitor from April through September along the coastline from Mexico to San Francisco. Winters in southern hemisphere and breeds along the Pacific Coast from Baja California to San Francisco Bay. In 1970, 300 pairs nested in 15 nesting sites located mostly on southern California beaches.

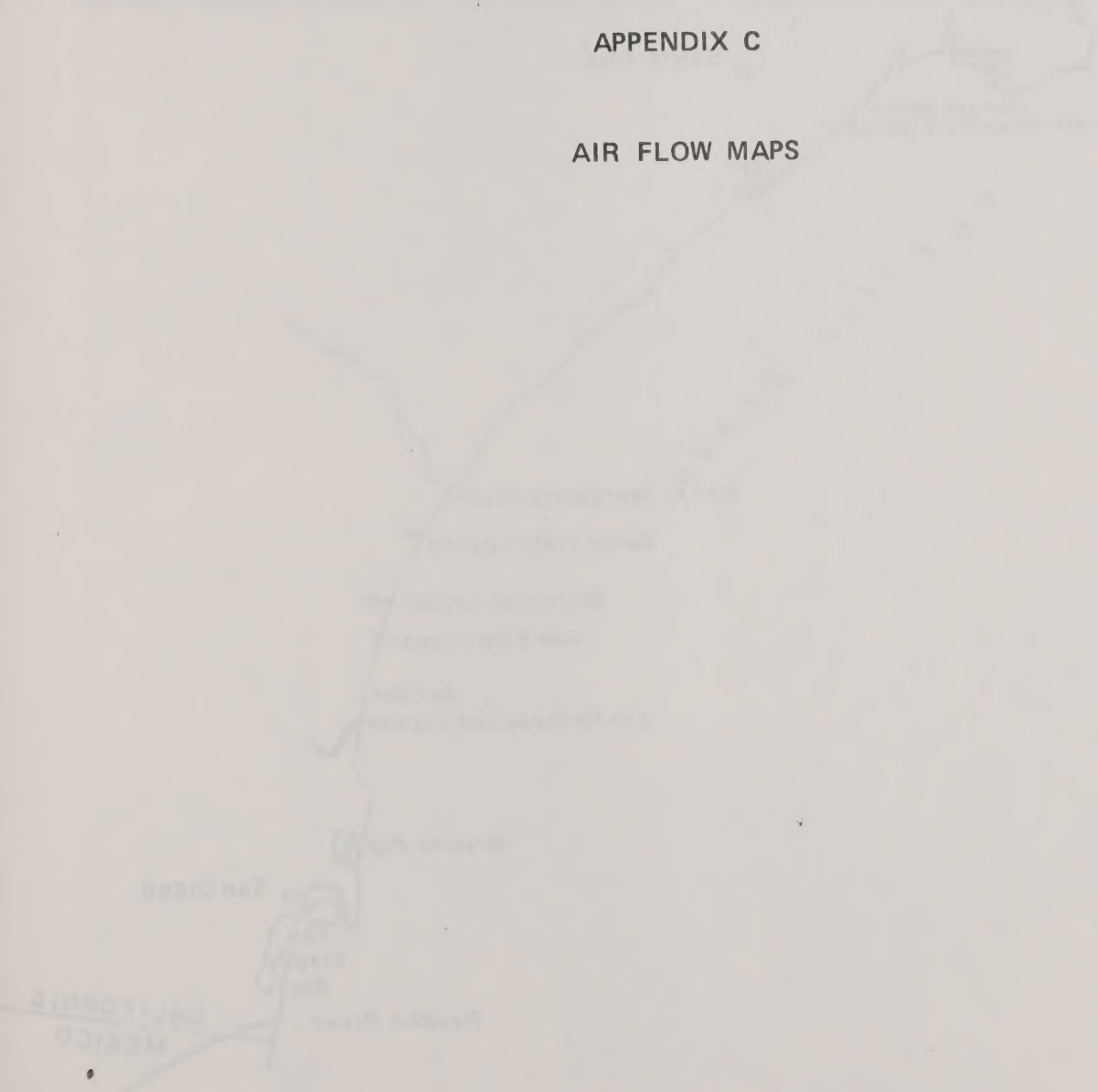
STATUS: Endangered. Habitat destruction and disturbance and predation are responsible for the rapidly declining population. Requires sandy beaches free from human disturbance to assure successful nesting.

PROTECTIVE MEASURES TAKEN:

- ... Fully protected bird under state law.
- ... Huntington Beach State Park Tern Sanctuary established by state.
- ... Santa Margarita River Tern Sanctuary established on Camp Pendleton Marine Base.
- ... Orange County Board of Supervisors has delayed development of Sunset Aquatic Park.
- ... Buena Vista Lagoon Ecological Reserve established by state.
- ... Nesting habitat developed by Navy at Seal Beach Naval Weapons Station.

APPENDIX C

AIR FLOW MAPS



CALIFORNIA LEAST TERN

RECOMMENDATIONS:

... Protect nesting areas critical to survival of the California least tern through acquisition, easement, or memorandum of understanding with landowners.

... Initiate programs of habitat management and protection immediately.

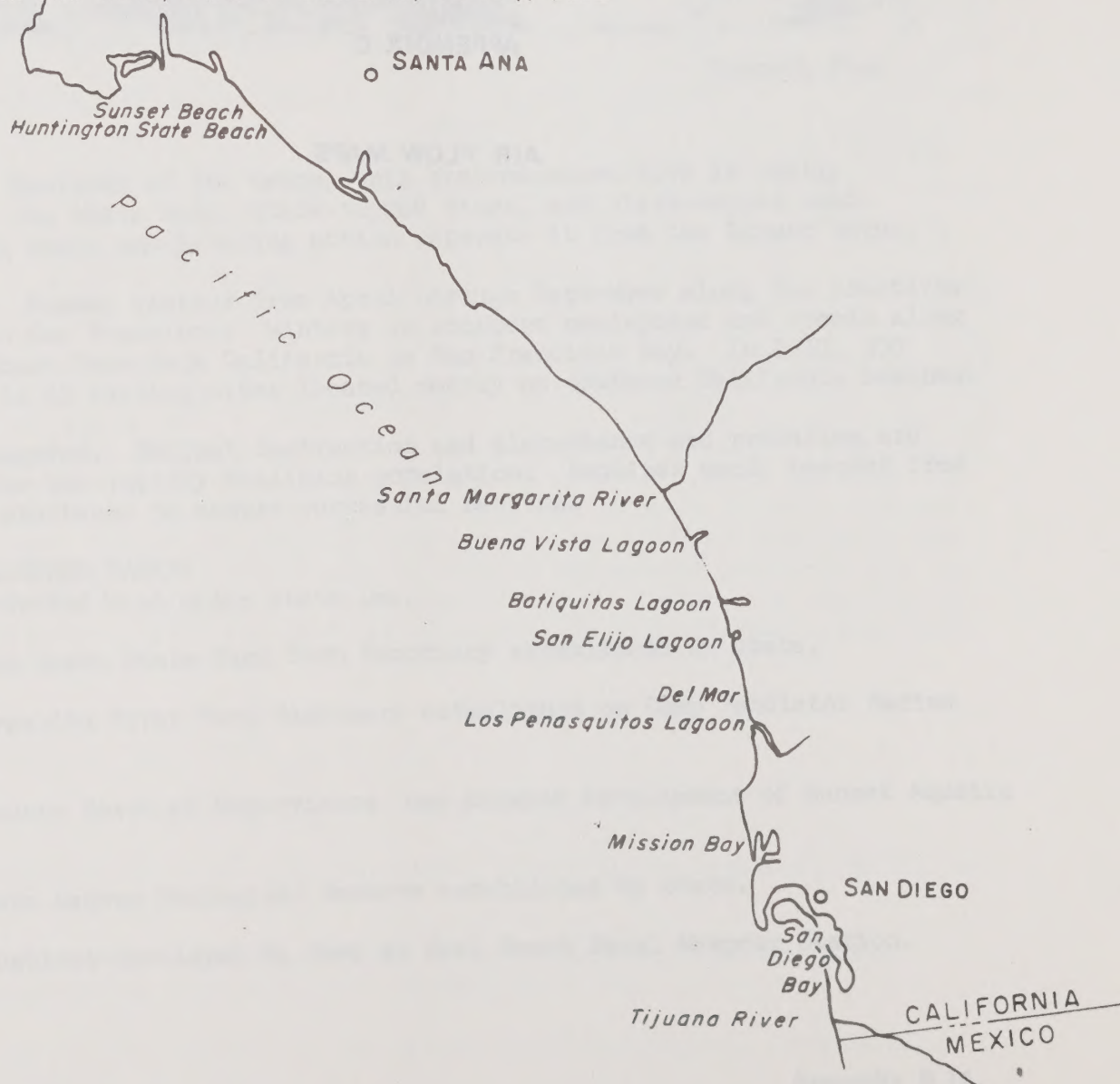
REFERENCES:

Craig, A.M. 1971. Survey of California least tern nesting sites. Calif. Dept. Fish and Game, unpublished, 112 p.

Massey, B.W. 1971. A breeding study of the California least tern. Wildl. Mgmt. Br. Adm. Rept. No. 71-9, 22 p.

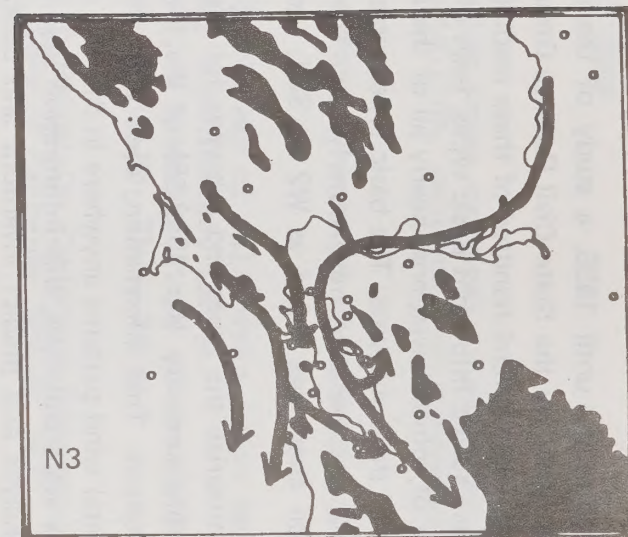
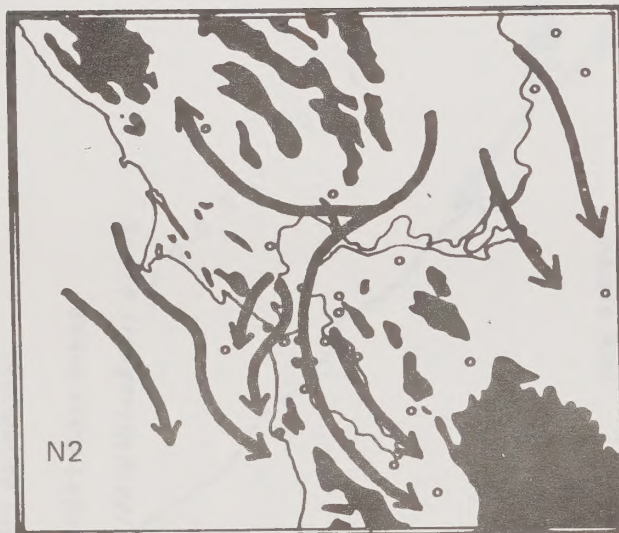
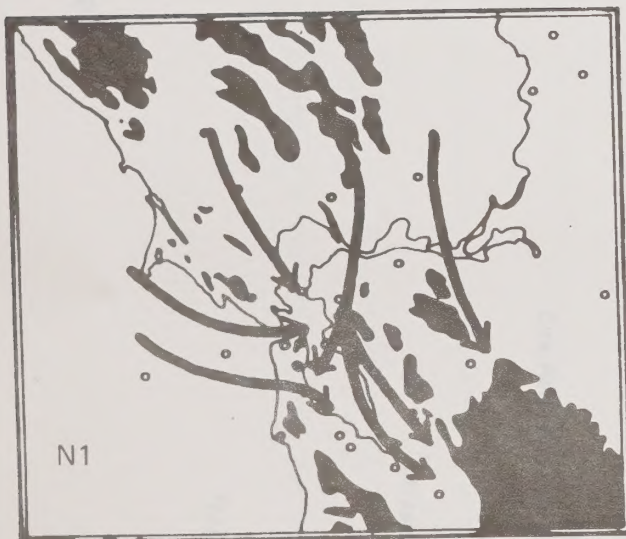
SOURCE:

At The Crossroads, A Report On California's Endangered And Rare Fish And Wildlife, Dept. of Fish and Game, State of California, January, 1972



Beginning early in 1951 and continuing until 1955, a study of the direction of windflow in the Bay Area was made every 6 hours by the State Civil Defense Group and the U. S. Weather Bureau. At the end of this period, when several hundred of these readings had been accumulated, the resulting windflow charts were sorted into eight basic types, each of which included a family of subtypes. With the exception of minor deviations, nearly all of the accumulated flow pattern charts could be assigned to one of these subtypes. The basic types were labeled as to the general airflow at low levels over the area, i.e., westerly, northeasterly, etc. The subtypes were arbitrarily labeled 1, 2, 3, etc., hence each chart was typed as W2 or SE4, etc.

The following airflow charts summarize the types and subtypes for the San Francisco Bay area. Following the charts is a monthly summary (for 1952-55) of the frequency of occurrence of each wind type at six hour intervals. This information, used with the windflow chart, makes it possible to anticipate the general wind patterns anywhere in the Bay area. Because air patterns have not changed since the data were collected, this information base is used by the Bay Area Pollution Control District to analyze and predict inversions and other air quality problems.



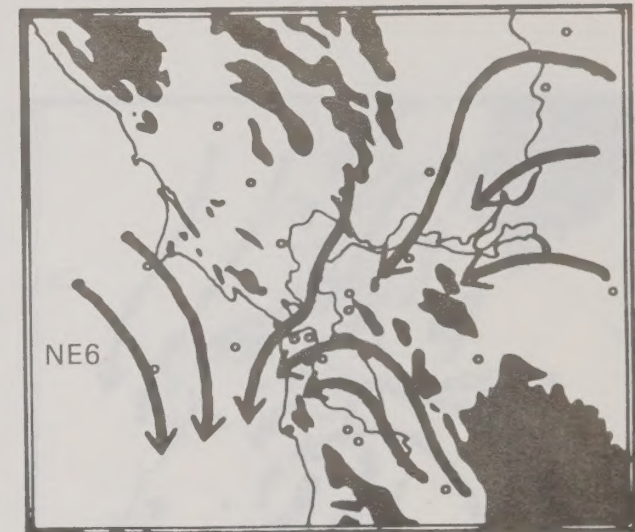
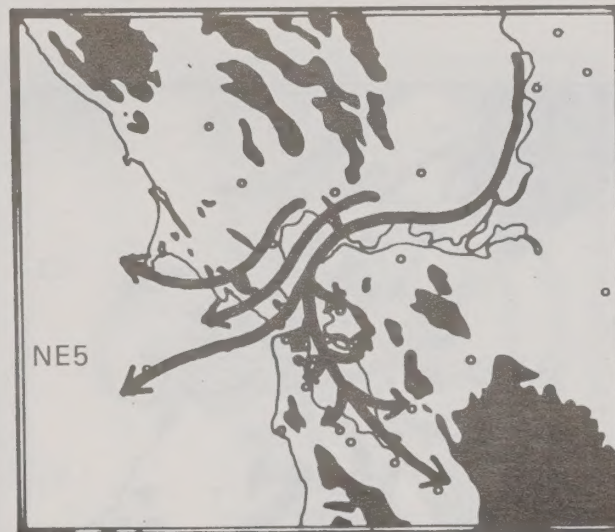
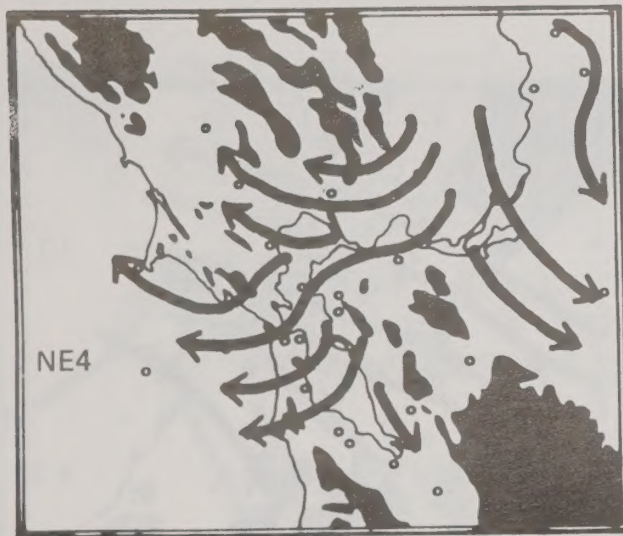
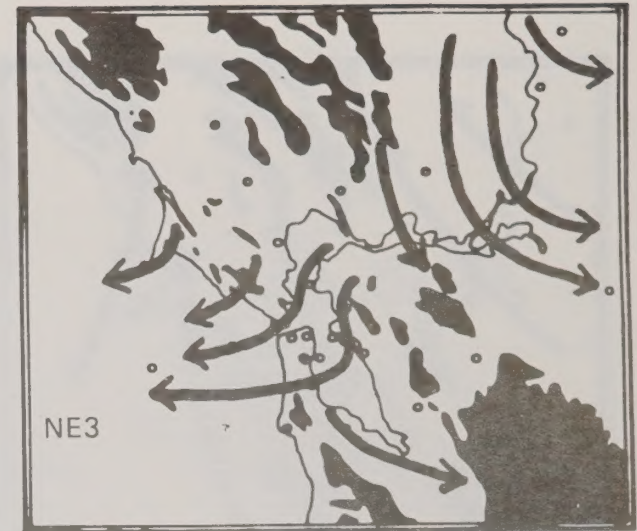
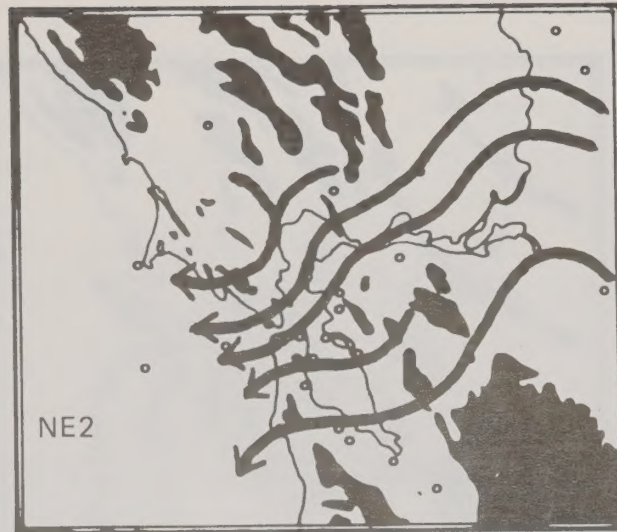
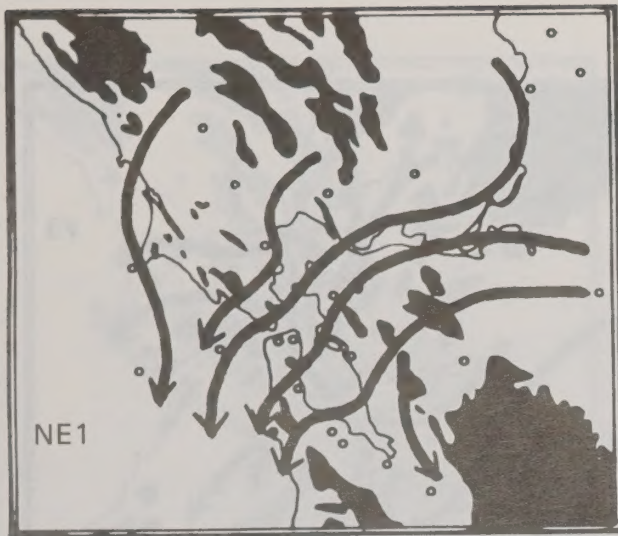
NORTH WIND FLOW TYPES



HILL MASS (TYPICAL)

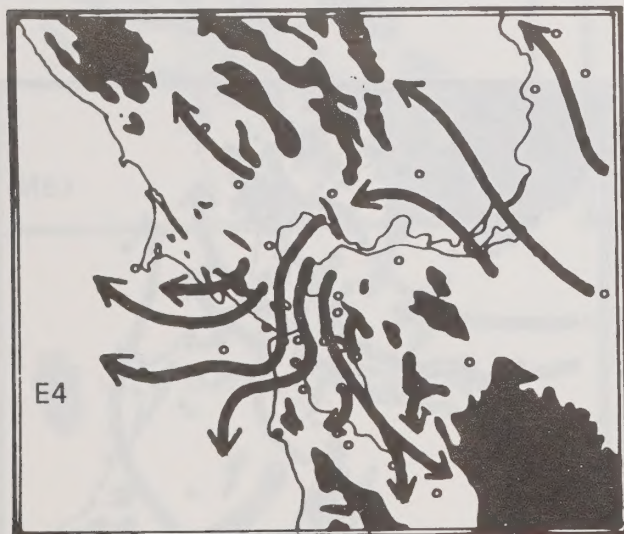
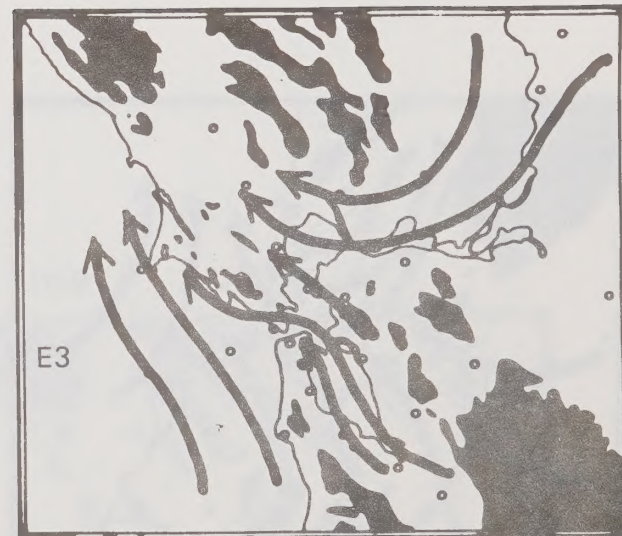
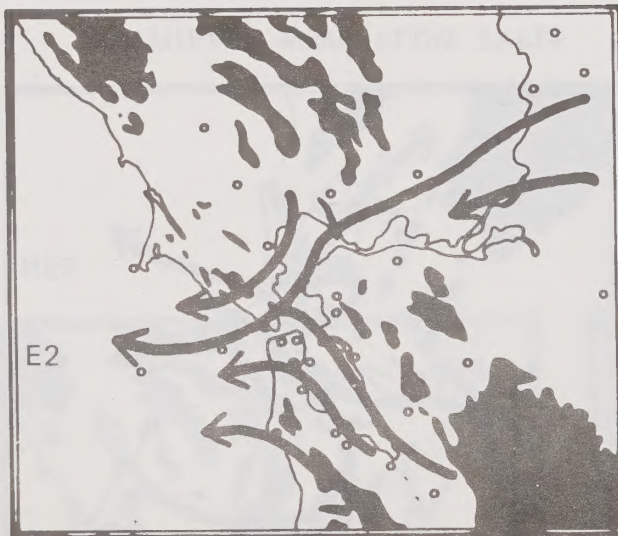
Source: Bay Area Pollution Control District
Information Bulletin 6-15-70,
 "A Study of Air Flow Patterns in
 The San Francisco Bay Area"

APPENDIX C.1

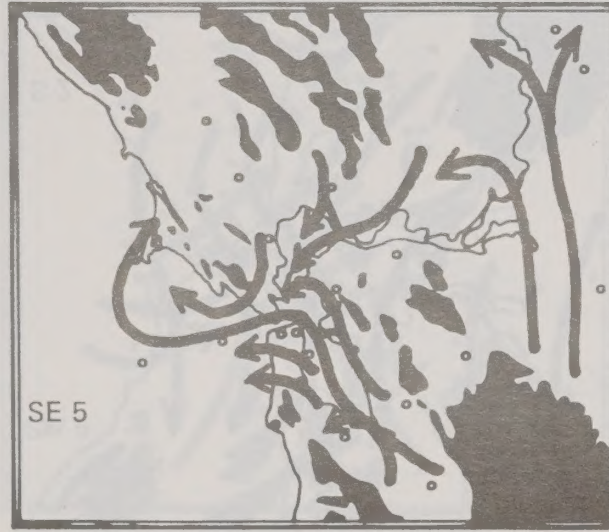
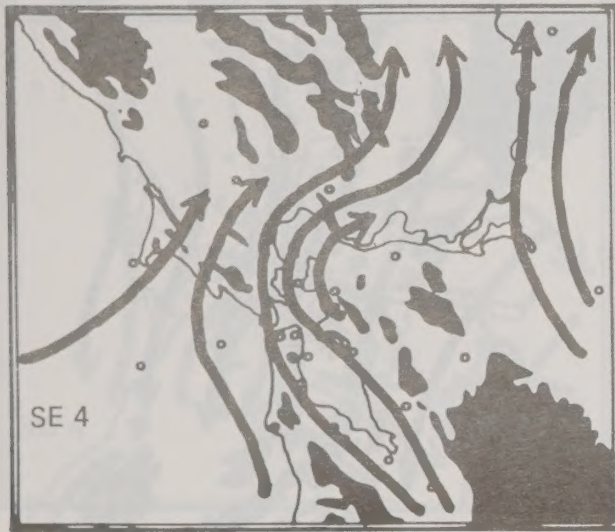
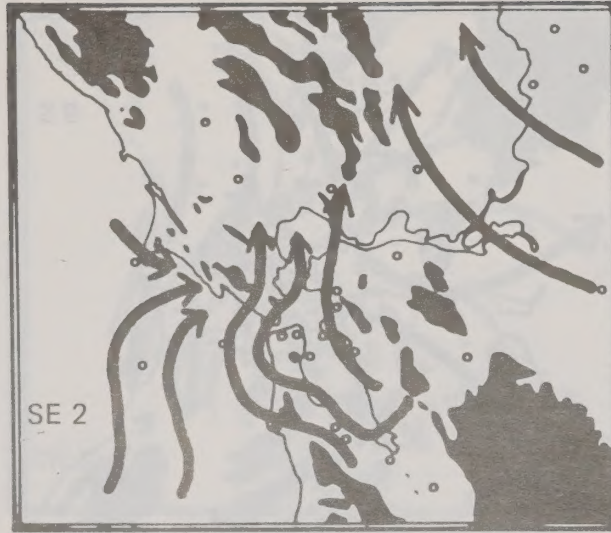
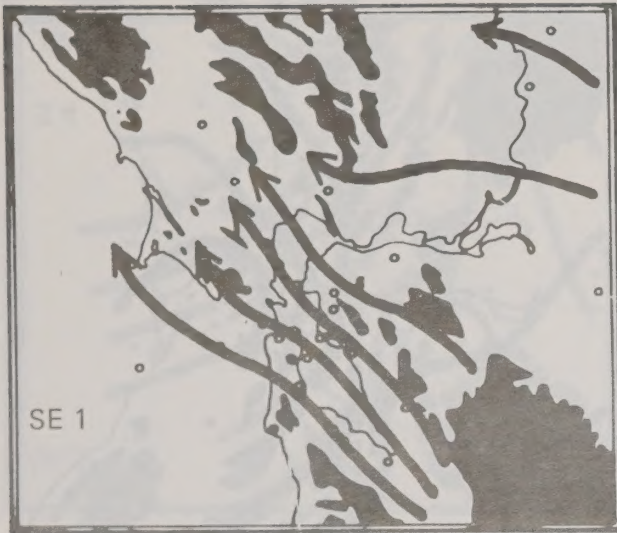


NORTHEAST WIND FLOW TYPES

 HILL MASS (TYPICAL)



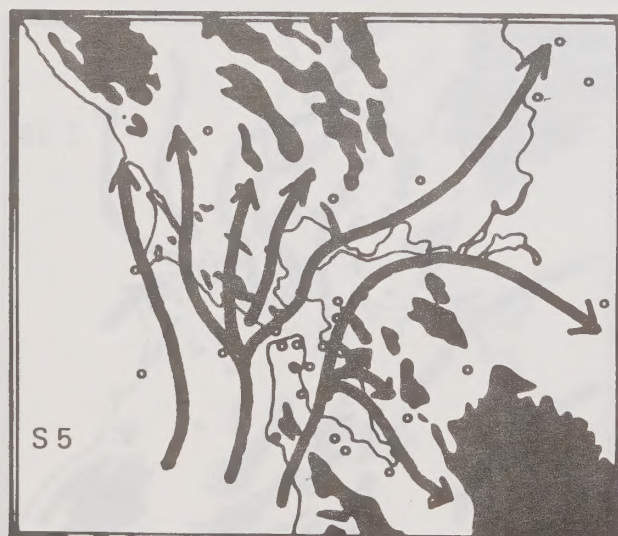
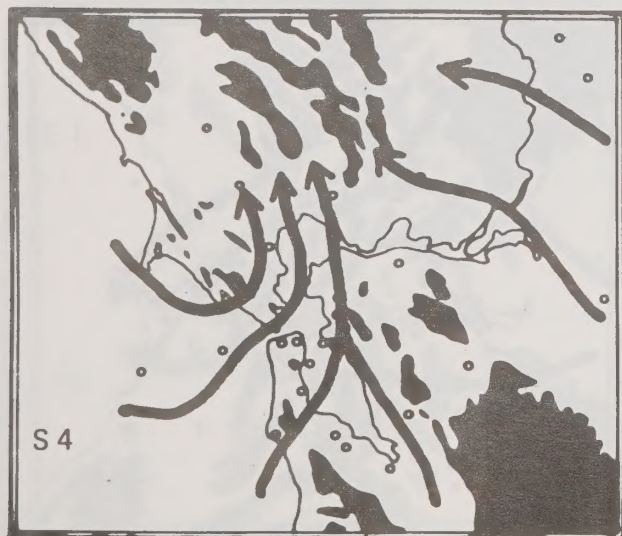
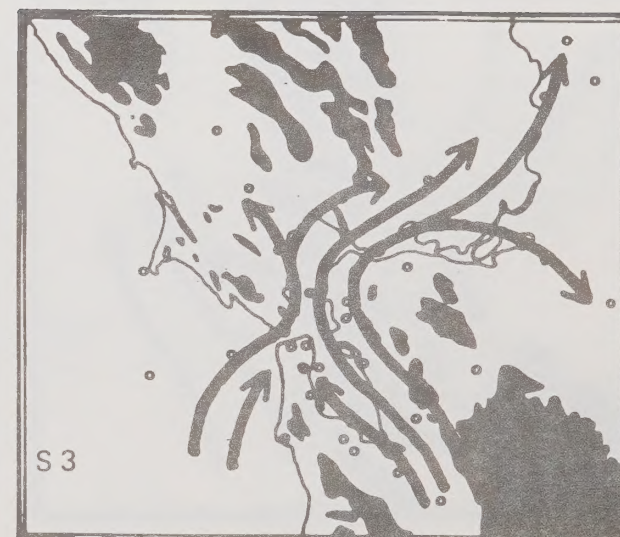
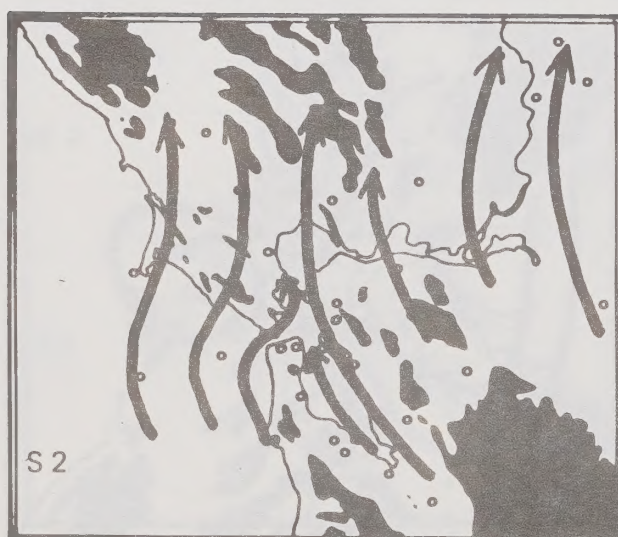
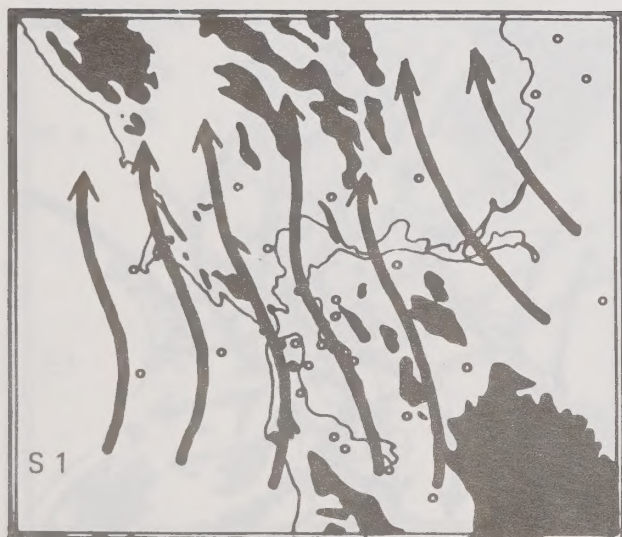
EAST WIND FLOW TYPES



SOUTHEAST WIND FLOW TYPES



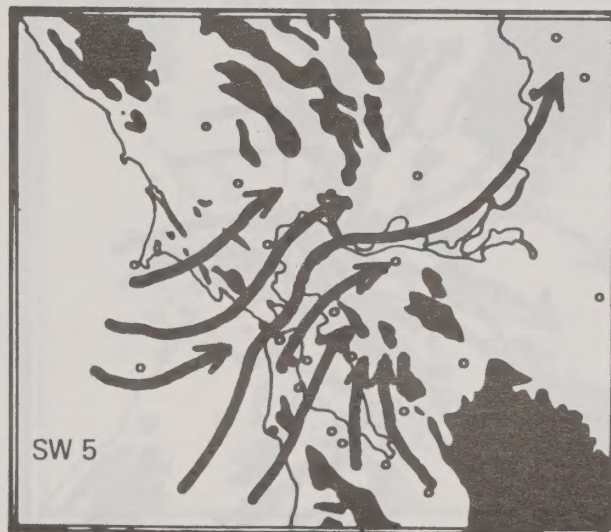
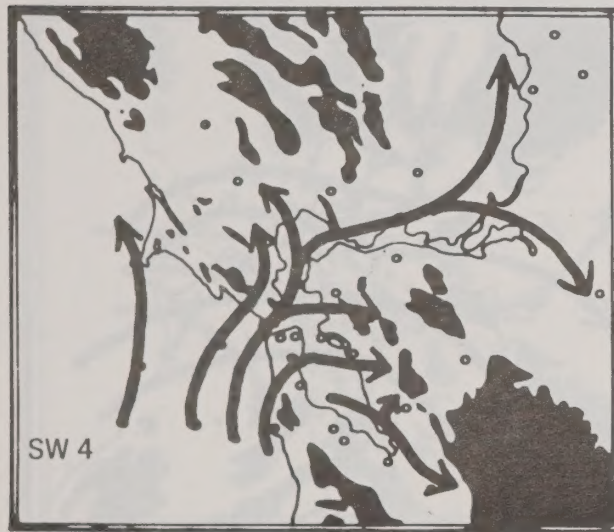
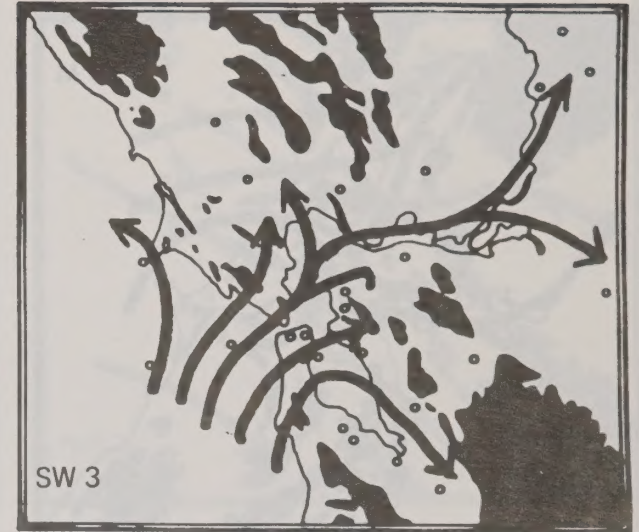
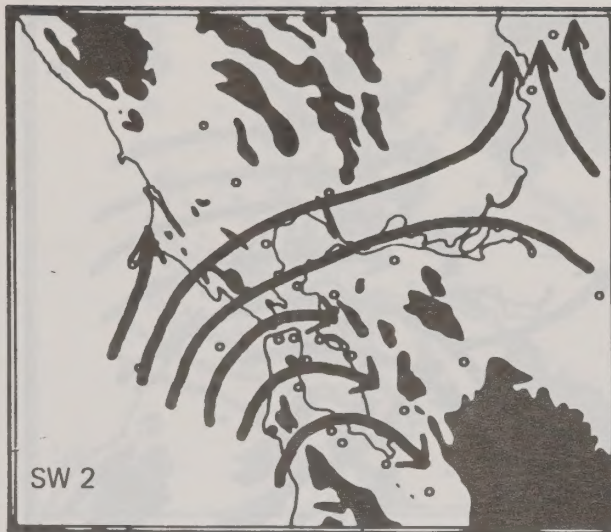
HILL MASS (TYPICAL)



SOUTH WIND FLOW TYPES

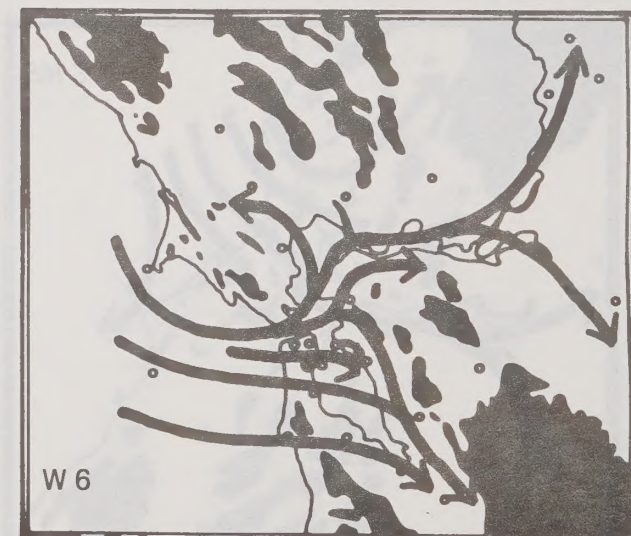
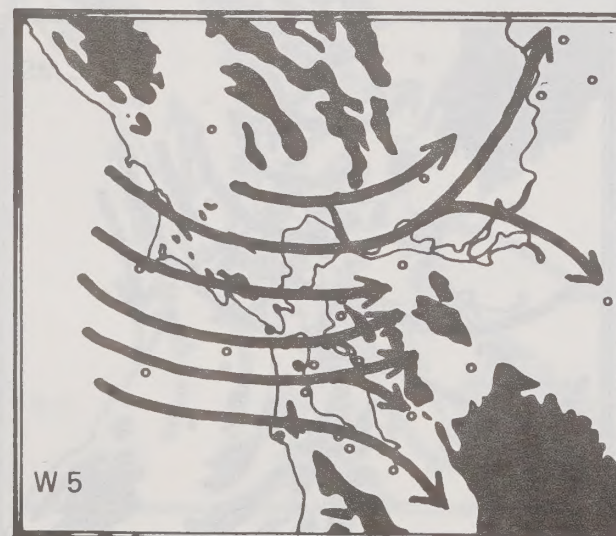
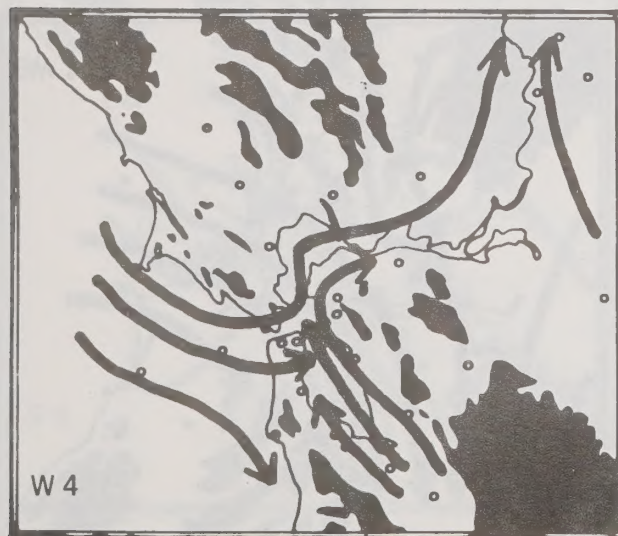
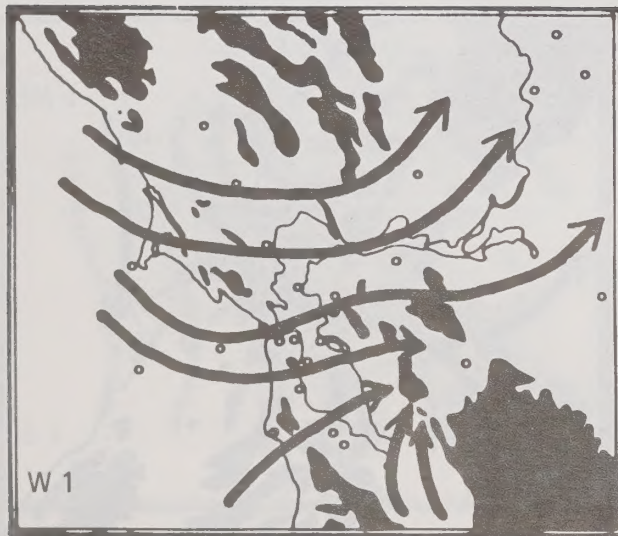


HILL MASS (TYPICAL)

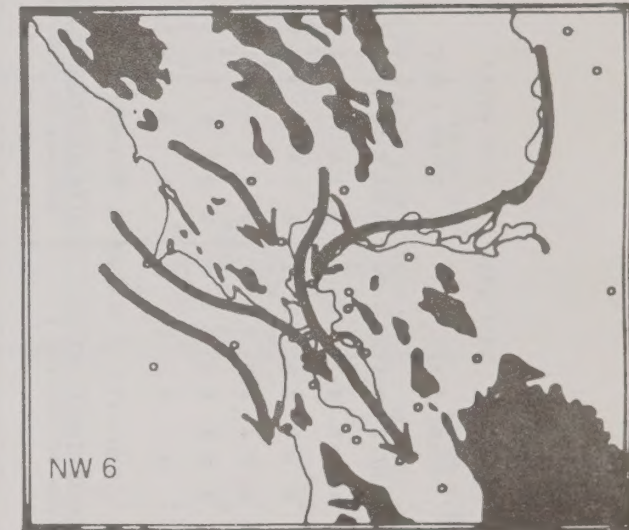
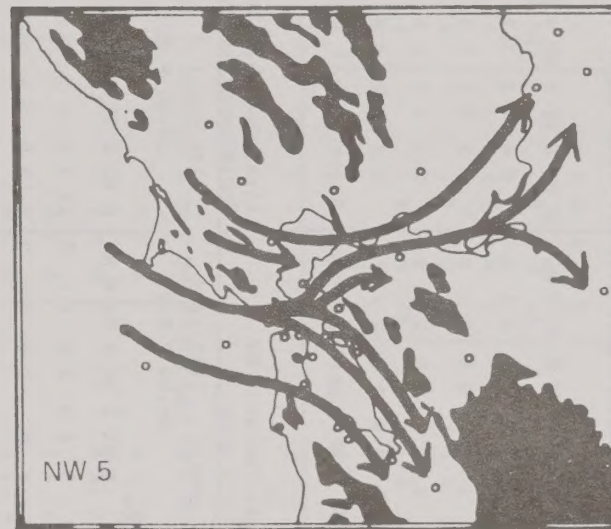
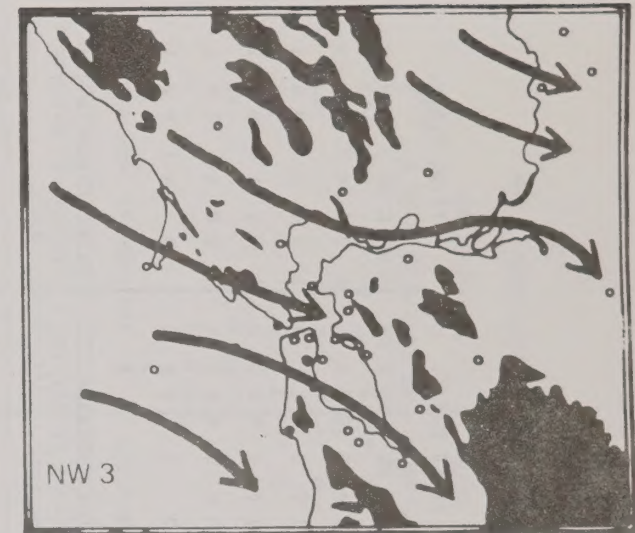
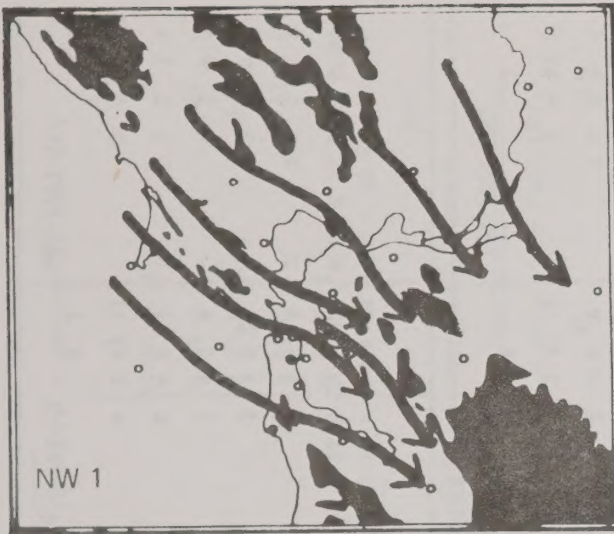


SOUTHWEST WIND FLOW TYPES

 HILL MASS (TYPICAL)



WEST WIND FLOW TYPES



NORTHWEST WIND FLOW TYPES

 HILL AREA (TYPICAL)

(124 days)

04:00 P.S.T.

10:00 P.S.T.

16:00 P.S.T.

22:00 P.S.T.

Type	N	NE	E	SE	S	SW	W	NW
I	4	1	0	2	7	3	2	2
II	3	0	8	2	5	0	0	1
III	0	0	1	1	0	0	0	0
IV	0	3	2	8	2	0	6	0
V		2		2		6		1
VI								
Light-Variable 48 Unclass or Missing 2								

FEBRUARY 1952-1955

(113 days)

Type	N	NE	E	SE	S	SW	W	NW	N	NE	E	SE	S	SW	W	NW	N	NE	E	SE	S	SW	W	NW	N	NE	E	SE	S	SW	W	NW
I	9	2	0	1	1	3	1	6	2	0	0	0	5	3	2	6	8	1	0	2	3	3	3	8	7	0	0	1	3	2	4	9
II	1	1	2	0	5	0	1	0	2	1	3	3	1	2	0	2	1	1	0	0	1	1	1	8	1	0	0	0	1	1	1	2
III	4	2	2	0	0	0	1	0	2	3	1	2	0	0	0	1	1	0	0	1	0	2	0	4	2	0	0	0	0	0	2	3
IV		2	3	2	3	0	3	2		4	0	2	3	0	0	4		2	1	0	0	0	1	2		1	0	0	2	1	2	6
V		3		1		2	0	1		6		1		2	2		6		1	1	1	2	1			1	0	0	1		2	4
VI		2					1			2					1								6	3		1					1	1
Light-Variable 46										Light-Variable 33							Light-Variable 23								Light-Variable 49							
										Unclass. or Missing 2							Unclass. or Missing 5								Unclass. or Missing 2							

MARCH 1952-1955

(124 days)

04:00 P.S.T.

10:00 P.S.T.

16:00 P.S.T.

22:00 P.S.T.

[illegible]

APRIL 1952-1955

(120 days)

Type																																			
T	N	NE	E	SE	S	SW	W	NW		N	NE	E	SE	S	SW	W	NW		N	NE	E	SE	S	SW	W	NW		N	NE	E	SE	S	SW	W	NW
I	2	0		2	1	2	4	1		2	0	0	0	5	2	0	9		1			1	3	4	8		2			2	1	1	12	3	
II		0		0	3	4	5	3		1	0	0	2	3	1	10	5		2			3	3	7	14					2	5	7	2		
III		1		1	1	0	1	3		1	0	0	0	2	4	1	6					2	4	0	8					3	2	3	3		
IV		0		3		2	15	10			0	1	2	1	2	2	4					0	4	1	3					1	1	1	6		
V		0				1	3	5			1			1	3	9	2					4	2	27	11					1	1	22	13		
VI		1						4							7	1								6	1							9	1		
Lgt-vrbl	41	Unclass	1							Lgt-vrbl	23	Unclass	7						Lgt-vrbl	1						6	1			Lgt-vrbl	16				

SEPTEMBER 1952-1955

(120 days)

Type	04:00 P.S.T.	10:00 P.S.T.	16:00 P.S.T.	22:00 P.S.T.
T	N NE E SE S SW W NW	N NE E SE S SW W NW	N NE E SE S SW W NW	N NE E SE S SW W NW
I	0 1 4 0	1 0 1 0 1 1	0 0 1 1	0 0 9 1
II	0 0 10 1	1 0 0 0 16 9	0 0 11 23	0 0 13 3
III	4 6 9 0	0 4 11 1 1	0 8 0 9	0 7 3 1
IV	0 1 9 2	0 3 00 3 1	0 1 0 3	0 1 5 3
V	1 6 10	0 1 12 6	2 30 11	3 20 15
VI	9	1 13	17	8 1
Lgt-vrbl 46 Unclass 1 Lgt-vrbl 33 Unclass 1 Lgt-vrbl 2 Unclass 1 Lgt-vrbl 27 Unclass 0				

OCTOBER 1952-1955

(124 days)

Type	04:00 P.S.T.	10:00 P.S.T.	16:00 P.S.T.	22:00 P.S.T.
T	N NE E SE S SW W NW	N NE E SE S SW W NW	N NE E SE S SW W NW	N NE E SE S SW W NW
I	3 0 0 0 10 9	6 1 0 0 1 0 1 7	3 1 0 0 0 0 7	1 0 0 0 0 6 8
II	1 0 2 1 5 3	2 0 0 0 1 2 13 7	1 1 0 0 2 9 21	1 0 0 1 5 18 7
III	0 0 1 2 1 1	3 2 0 4 3 2 1 3	0 0 6 0 5	1 0 0 2 4 2 1
IV	0 3 0 1 7 2	0 2 0 3 1 1	1 0 1 0 3	0 2 1 1 4 0
V	1 1 3 3 5	1 2 5 4	7 1 10 14	0 4 9
VI	3	2	19 3	1 1 1
Lgt-vrbl 65 Unclass 0 Lgt-vrbl Unclass 0 Lgt-vrbl 6 Unclass 0 Lgt-vrbl 42 Unclass 1				

NOVEMBER 1952-1955

(120 days)

Type	04:00 P.S.T.	10:00 P.S.T.	16:00 P.S.T.	22:00 P.S.T.
T	N NE E SE S SW W NW	N NE E SE S SW W NW	N NE E SE S SW W NW	N NE E SE S SW W NW
I	2 1 0 5 5 0 6	2 1 0 6 7 0 0 8	5 1 0 4 5 3 4 9	1 2 0 6 4 0 5 10
II	0 0 2 0 0 2 1	1 1 1 1 4 1 0 1 1	5 1 1 0 1 3 5 5	0 0 1 0 1 1 2 1
III	2 1 1 1 1 0 1	2 0 0 3 1 1 2	4 2 0 3 0 0 5	2 0 1 1 1 1 3
IV	1 1 1 1 1 7 1	0 0 1 0 3 1	0 0 1 1 0 2 4	0 2 1 0 3 0
V	1 1 1 2	3 4 1 0 2 0	4 1 1 4 0	2 2 1 4 1
VI		3 1 1	2 5 1	1
Lgt-vrbl 70 Unclass 2 Lgt-vrbl 53 Unclass 4 Lgt-vrbl 27 Unclass 3 Lgt-vrbl 61 Unclass 0				

DECEMBER 1952-1955

(124 days)

Type	04:00 P.S.T.	10:00 P.S.T.	16:00 P.S.T.	22:00 P.S.T.
T	N NE E SE S SW W NW	N NE E SE S SW W NW	N NE E SE S SW W NW	N NE E SE S SW W NW
I	4 0 0 8 7 1 1 5	3 1 0 15 11 2 1 10	3 0 0 12 11 3 5 11	2 1 0 10 12 2 1 11
II	0 3 6 3 2 2 0	2 6 5 0 1 1 0	2 2 3 0 0 2 0 1	0 3 2 2 1 1 0
III	1 1 1 0 0 0 0	2 3 1 0 0 0 0	1 4 1 0 0 0 3	1 0 0 1 0 0 0
IV	3 3 1 8 4 4	3 3 0 5 2 0	4 3 1 3 0 1	2 4 2 5 5 4
V	1 4 1 0	5 4 1 1 1	9 4 6 1	4 5 4 0
VI	4	1	2 2	
Lgt-vrbl 43 Unclass 3 Lgt-vrbl 34 Unclass 0 Lgt-vrbl 23 Unclass 2 Lgt-vrbl 38 Unclass 1				

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